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THE FUNCTION OF THE VAN VLECK OBSERVATORY.*

FREDERICK SLOCUM.

There is evidently much doubt in the minds of some people as to just what an observatory is, and what it is for.

A teamster came up here some time ago with a load of window frames for the new dormitory. When told that he had come to the wrong place, that this was the observatory not the dormitory, he paused a moment and then asked, "Well, what's the difference anyway?"

An expressman one day enquired about the significance of the building, and when informed that it was for the study of the heavens, remarked that he hoped it would do some good.

A neighbor reports a conversation with her maid, who asked about "that queer building up on the hill." When she was told that it was an observatory and contained telescopes through which the students looked at the sun, moon, and stars, she replied: "They'd much better look into their own hearts. That's what I think."

The building has been likened to a fort, and the dome to a bee-hive, and even to a sore thumb. The most encouraging comment on the exterior appearance of the structure is one by a member of the Wesleyan Faculty, which I take the liberty of quoting.

> "Little bits of plaster,
> Little blocks of stone,
> Make a handsome building,
> When the ivy's grown."

The observatory does not, as one of the papers stated last Sunday, combine all of the best features of the best observatories in Europe and America, but it does contain as many desirable features as our fund would allow.

* Read at the dedication of the Van Vleck Observatory of Wesleyan University, June 16, 1916.

The function of the Van Vleck Observatory of Wesleyan University, it seems to me, is twofold; instruction and research. In some universities there is a sharp line of demarcation between these two, and such a division may be necessary in the case of very large classes, but, to my mind, research is one form of instruction and instruction without research is apt to become dry. The two should go hand in hand, or at least, if possible, should be carried on under the same roof.

Someone has likened a course in astronomy to a trip abroad. The pleasure of travel and its broadening effect are of course recognized, and there is a similar widening of the vision from a personally conducted tour through the heavens with a telescope. From this point of view alone courses in astronomy would be justified, but there are other characteristics equally worth considering.

The courses now offered here at Wesleyan are of four quite different types. First there is a general descriptive course, chiefly informational in character. A standard elementary textbook is used, and just enough laboratory work or rather observatory work is introduced to make the text perfectly clear. Second, a course in the history of astronomy. This might be classed as purely cultural. There is no adequate text on this subject, so the course is conducted by lectures illustrated with the telescope and by photographs and lantern slides.

We begin with the birth of astronomy among the shepherds on the Chaldean hills some 3000 years B. C., trace its development in Greece, noting especially the part it played in the philosophy of Pythagoras, Plato, and Aristotle, then follow its history in Alexandria, Babylon, and Spain. Passing over the dark ages, we dwell a little longer upon the great revival in Europe, in which five great men stand out so prominently: Copernicus the Pole, Tycho Brahe the Dane, Kepler the German, Galileo the Italian, and Sir Isaac Newton the Englishman. At the hands of these five men the science of astronomy was completely revolutionized and started upon a new line of development, which has continued, ever becoming more extensive and intensive, culminating in the wonderful discoveries being made with the various forms of spectroscopes in recent times. Only the general characteristics and most prominent features of this development are discussed. The aim is to give the student a general idea of what is included in the science of astronomy, how the science has developed, and its relation to other branches of learning.

The third course is one in practical astronomy. The students from the very beginning use instruments, make observations, and reduce them. They deal with such problems as the determination of accurate time as used for railroad and other commercial purposes, and the

determination of latitude, longitude, and azimuth, as used in the higher surveying on land, and in navigation at sea.

The remaining courses may be included in one class. They are all laboratory courses and deal with the more difficult problems of theoretical and practical astronomy. They may be grouped together because of one common characteristic. These classes will always be small and the students will, to some extent, take part in the routine research work of the observatory, thus getting some insight into the methods of modern astronomical investigation.

When the first plans of this building were being drawn, it was recognized that its chief function was to be the teaching of astronomy, and the question arose as to whether it would be better to equip it with

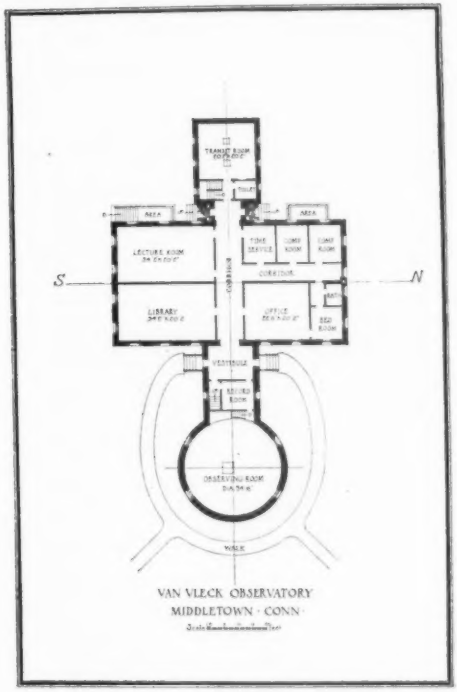


FIGURE 1.
PLAN OF THE MAIN FLOOR OF THE VAN VLECK OBSERVATORY.

a number of small instruments, or with a single telescope as large as the fund would allow. With two or three small telescopes, more of the students in the elementary courses would be able to make some simple observations. With the single larger instrument, the phenomena of

descriptive astronomy could be better illustrated, research work of some value could be done by the director, and advanced students, and, it was thought, that not only the advanced students, but those in the elementary classes as well would derive greater inspiration from this higher grade of work, and, as you know, the second plan was finally adopted.

In discussing this phase of the function of the observatory the problem of the entertainment of visitors should perhaps be considered. Scarcely a day passes without a request from someone to be shown through the building. On Washington's Birthday about 200 people were thus entertained. A number have asked permission to visit the observatory at night and to look through the telescope. This has been granted whenever it could be done without conflicting with the regular night classes.

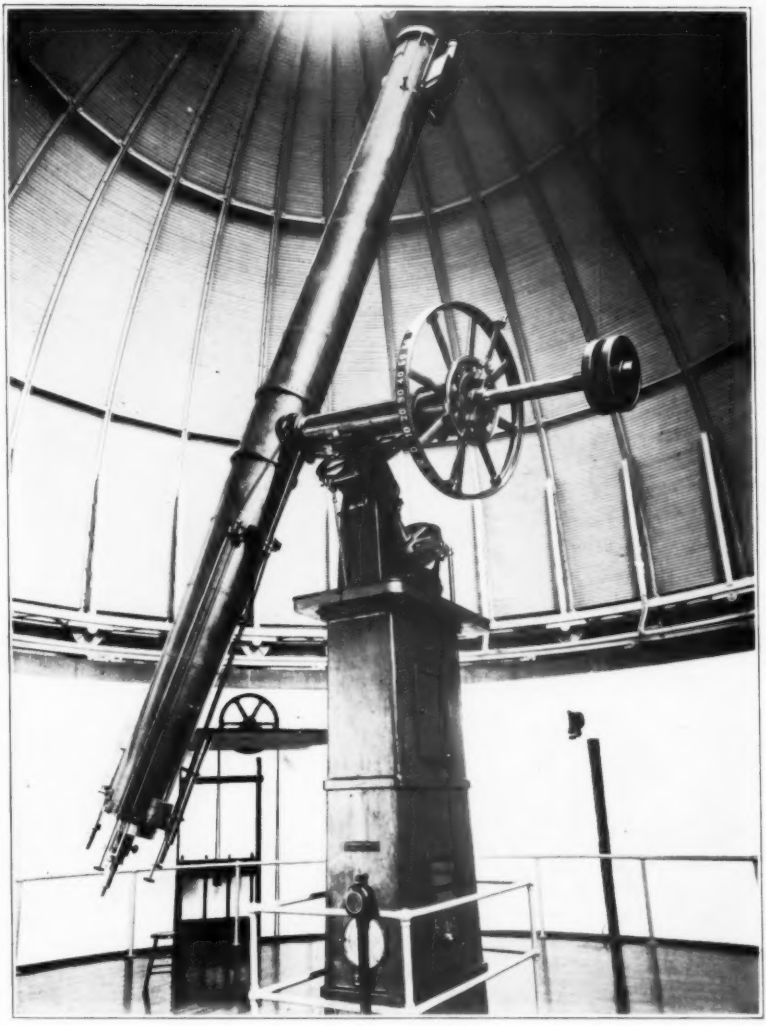
In some cases the visitors have come apparently out of mere curiosity rather than through any interest in the subject of astronomy. However, such curiosity is, no doubt, perfectly legitimate, and I believe that the observatory ought to make some provision to satisfy it. It may be possible next year to set apart certain days and perhaps one or two evenings per month for visitors.

As to the research program of the observatory, from some of the replies to the invitations to the dedication, I have been able to learn, to some extent, what is expected. For example one alumnus writes, "We expect great results from you in the future. If you do not discover a tenth moon of Jupiter, we fully expect you to do some other work which the alumni will recognize and appreciate."

Now I have not the slightest idea of hunting for a tenth moon of Jupiter, and if I ever should find one, it would be purely by accident. In this connection I am reminded of a story which appears in the biography of Galileo. In the year 1604, while Galileo was a professor at Padua, a new star blazed out in the constellation of the Serpent and attracted great attention, chiefly, perhaps, because it apparently contradicted the teachings of Aristotle and the church, that the heavens were unchangeable, perfect, subject neither to growth nor to decay. Galileo was invited to give a course of three lectures on the new star. At the first lecture there were over 1000 people, and the second lecture had to be given in the open air because there was no hall in the city large enough to hold the audience.

In opening his first lecture he took occasion to rebuke his hearers for thronging to learn about that transient phenomenon, while showing absolutely no interest in the far more wonderful truths about the permanent stars.

PLATE XXIV



THE EIGHTEEN AND A HALF INCH TELESCOPE OF THE VANVLECK OBSERVATORY. RISING FLOOR ABOUT THREE FEET ABOVE THE LOWEST POSITION.

Occasionally, to be sure, the sensational serves a good purpose by attracting the attention of some genius whose interest in the science remains after the ephemeral novelty has passed. For example it was the blazing out of a new star that led Hipparchus to make the first star catalogue. And again it was the appearance of a new star which started Tycho Brahe on his astronomical career, but his great contribution to astronomy is the long series of careful and laborious observations of the motions of the planets.

In planning the program of research for this observatory I have adopted the following precepts:

First, the sensational or transient phenomena should be ignored, or, as least, subordinated to the problems which will yield positive results of permanent value.

Second, the problems to be studied should be such as can be satisfactorily investigated in the relatively bad climate of New England. An eminent astronomer has recently told us that it is absolutely useless to try to see any exceedingly faint and delicate markings like the canals on Mars in New England. The atmosphere is rarely, if ever, sufficiently transparent or steady enough.

Third, the telescopic equipment which could be provided from the available fund must be considered.

And finally, the experience and training of the astronomer must be taken into account.

With these conditions and limitations in mind I have searched the frontier of astronomy for the most suitable problem.

In every age there have been certain great problems in astronomy which have overshadowed all the rest.

For example among primitive people it was the question of the shape of the earth, as to whether it was flat or spherical. Later it was the rising and setting of the sun, moon, and stars. How were they carried across the sky? Were they borne on crystal spheres, or did they just fly over like a stone that is thrown? And how did they get back from the west to the east every day? Were they carried around behind the northern mountains, or did they pass through some underground channel? And were the lights of the stars extinguished when they went down into the western sea, and relighted in the east twelve hours later?

Again it was the motions of the planets that puzzled the astronomers; rising and setting like the stars, but unlike the stars, zigzagging back and forth and describnig loops and curves. The Ptolemaic System of epicycles—wheels upon wheels—finally solved this problem to the satisfaction of most astronomers for about 1500 years, then it was completely overthrown.

The next great problem was the question of the influence of the heavenly bodies upon human destiny, and during the fourteenth and fifteenth centuries the astrologer was a dominant factor in every court in Europe. Today, however, astrology is, of course, wholly discredited.

Once more the question of planetary motion came up, and was almost completely solved. The size and shape of each orbit around the sun was correctly determined, and the fact that the motions of the planets are due to the attraction of gravitation was proved by Sir Isaac Newton. All that remained was to explain what gravitation really is. This problem is, of course, still unsolved.

During most of the eighteenth century astronomy was concerned chiefly in making catalogues of the positions of the stars and planets; very important but somewhat monotonous.

Towards the end of the century, however, a new problem arose, that of locating the stars in space, and of answering such questions as these: Is the number of stars infinite or finite? Do the stars form a system? Are they confined within a finite limit, or do they extend through all space? Are the stars really fixed, or are they moving, but so far away that their motions are imperceptible? Is our sun fixed or in motion? Are the star clusters really separate sidereal systems, far away? What is the Milky Way? Such questions as these characterized the great problem of the eighteenth century.

Again the pendulum of interest swung back to the planets. With the discovery of Uranus, the Asteroids and Neptune, attempts were made to explain the origin and development of the solar system. The Nebular Hypothesis and other theories were the result.

During the latter part of the last century the discovery of the principles of spectrum analysis and the introduction of photography into astronomy opened up the new field of astrophysics, which deals especially with the study of the chemical composition of the stars.

These are just a few of the great problems of the astronomy of the past. Now the greatest astronomical problem of the present time, it seems to me, is precisely that one of the eighteenth century which deals with the determination of the structure of the sidereal universe, but in our day it is being attacked in quite a different way. In fact, it is being attacked in a great variety of ways.

First of all it is, of course, necessary to determine the actual distances of the stars, but it has been found that closely connected with their distribution in space are many other characteristics, for example, the magnitudes or brightness of the stars, their motions, apparent or real, their spectral types or chemical composition, to a certain extent their physical natures, densities and masses, and their grouping into

clusters; also the status of the nebulae and the interpretation of the Milky Way must be considered.

It may seem natural that the nearer stars should, on the average, be brighter than the more distant ones, and that the nearer stars should appear to move the faster, but it is not so evident why the so-called metallic stars should be nearer than the hydrogen or helium stars, nor is it so clear why there should apparently be a relation between the evolution of the stars and their distances from our sun.

This question of the interpretation of the structure of the stellar universe is so broad that, so far as I know, there is but one observatory in the world that is trying to attack it along all possible lines, and that is the Mt. Wilson Solar Observatory, of which our distinguished guest is the director.

With our modest equipment here at Wesleyan, it will be necessary to concentrate our attention chiefly upon one single line, and I have therefore selected as the main item on our research program the determination of the distances of the stars. This, it seems to me, is, all things considered, the kind of work which can be done most satisfactorily in our climate and with our equipment. The details of the proposed observations would not interest you. It is sufficient to say that the work will be done by photography and the plates will be measured on a machine which you will see later in the computing room.

The field for this line of work is practically unlimited, and one observatory cannot possibly cover it all. Last year the American Astronomical Society appointed a committee to promote the coöperation of as many observatories as possible in the determination of stellar distances. As a result of their labors, eight observatories have agreed to include this problem in their research program. The eight are the Greenwich Observatory, in England, and, in this country, the Mt. Wilson Solar Observatory, the Yerkes Observatory, and the Observatories at the University of Virginia, Swarthmore, Northwestern, Allegheny, and Wesleyan.

This particular investigation will probably not produce any sensations, but it is hoped that it will yield results of permanent value. Other subordinate problems will of course be investigated whenever it is possible to do so.

Now just a word in regard to the general methods of astronomical research. The popular idea is that, whenever the spirit moves him, the astronomer simply sits at his telescope and watches the heavens in the hope that he may see something new, but such is by no means the case. Strange as it may seem, the efficiency germ is gradually working

its way into the observatories. The astronomers realize the value of their equipment and seek to make the best possible use of it. The big telescopes are never allowed to stand idle when the weather conditions are such that observations can be made. For example, in the case of the great 40-inch telescope of the Yerkes Observatory, every hour of the night, from about half an hour after sunset to half an hour before sunrise, is assigned to some member of the staff, and each one is supposed to be on duty during the hours assigned and to use the telescope for the definite problem on his program, whenever the sky is clear. During the daytime the instrument is used for observations on the sun.

Again, while the telescope is in use, every precaution is taken to avoid waste of time. The work is nearly all done by photography, and two men are always in the dome. While one is exposing a plate the other is writing up the records and selecting the next region to be photographed. As soon as the time is up, one goes to the dark room to take out the exposed plate and put a fresh one in the plate holder, while the other is setting the telescope for the next exposure.

Similarly in measuring the plates and carrying out the reductions, the attempt is made to introduce the most efficient methods. Mechanical computing machines are used whenever possible, and all elementary routine work is turned over to computers and assistants.

This, of course, is an ideal scheme, but it takes men and money. Five men are required to keep the Yerkes telescopes working full time, and twice that number of assistants and computers should be provided for the reduction of their observations. At the Harvard Observatory there is a staff of about forty, including all assistants, and at the Mt. Wilson Observatory between fifty and sixty. These are two of the greatest research observatories in the world. How small these figures make our little plant look! However, it will grow, somewhat at least. In our plans of the building we have tried to provide for some expansion in the future, not so much along the line of instrumental equipment as in personnel. It is my ambition to see this telescope used every clear night, all night, and, to a certain extent, during the daytime. At present this is of course physically impossible, but I hope that some day we may be able to approach more nearly the goal of our ambition. One additional observer and a computer would easily treble our output.

Such then is our program: instruction combined with systematic research in connection with one or more definite problems. If I were to choose a motto for the observatory I think it would be "Concentration and Efficiency."

I sincerely regret that in planning this building I did not have the

counsel and advice of two men, the memories of whom are uppermost in my mind today. I refer to Winslow Upton, late professor of astronomy in Brown University, and Professor John M. Van Vleck.

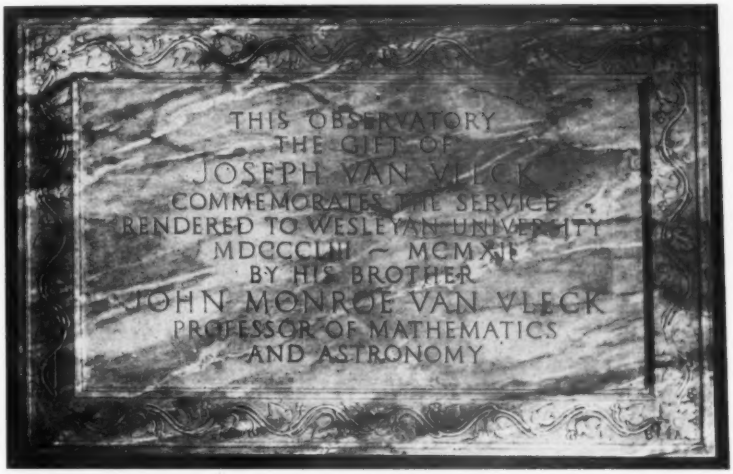


FIGURE 2.

TABLET IN THE MAIN CORRIDOR OF THE VAN VLECK OBSERVATORY. IT IS OF SIENNA MARBLE, 33x52 INCHES.

It was Professor Upton who inspired me to take up astronomy as a profession, and during the fifteen years in which I was associated with him, I learned to know and honor him as a great and noble teacher and a sincere and loyal friend. To him I owe more than I can express.

Though never intimately associated with Professor Van Vleck, I nevertheless had the good fortune to know him slightly, having met him occasionally at the astronomical meetings, but since coming to Wesleyan, I have learned to appreciate much more fully his inestimable value to the college and to the world by his services as teacher, administrator, and scientist.

My great ambition is that I may prove to be a worthy successor to the man whose name this observatory bears.

ADDRESS OF EDWARD B. VAN VLECK AT THE DEDICATION OF THE VAN VLECK OBSERVATORY.

This is the day that my father longed to see. For fifty long years he served Wesleyan University. When he came to the University, all science was included under the good old fashioned, though ill defined title of natural science, with the exception of astronomy and theoretical physics which were united with mathematics. Later physics was made a distinct department, but mathematics and astronomy remained united during my father's life time. To the end his title was that of professor of mathematics and astronomy. So far as I know, he was the last professor in an institution of high rank to hold this double title. And it was fitting.

For from immemorial times the two departments have been noted for their interaction. Thales, one of the ten sages of antiquity, was the founder alike of Greek mathematics and astronomy, while Hipparchus, the greatest of Greek astronomers, is credited with the invention of trigonometry. Ptolemy, Kepler, Euler, Lagrange, Laplace are only a few of the great names of the centuries famous in both mathematics and astronomy. Gauss, whose fame in pure mathematics can scarce be eclipsed, laid in the Theoria Motus, which my father loved above all to teach, the foundation of the mathematical theory of the heavenly bodies. I do not hesitate to characterize the era from the invention of calculus in the seventeenth century to about 1825 as the gravitational or astronomical epoch of mathematics, in which mathematics was the handmaid of astronomy.

No sign of the coming cleavage between these two departments of thought had even begun to appear when my father, almost immediately after graduation, went to Cambridge to begin his lifelong work upon the "American Ephemeris and Nautical Almanac", which had just been instituted in 1849 with Benjamin Pierce as consulting astronomer. This brought my father for two years in early manhood under the influence of one of the notable men of the country. In Pierce the mathematical and astronomical talents were harmoniously combined. He stands out even today as the first productive American mathematician, an isolated, solitary figure. In astronomy his position is not equally unique. Yet, if I understand rightly, he was one of the three

great influences which molded American astronomy, sharing with West Point Science and the Naval Observatory the glory of raising it to international celebrity, a position it has never since lost.

To-day how changed the relations of astronomy! On the purely theoretical side it tends to become, I think, increasingly a province of the pure mathematician, while on the experimental side it has been in good measure annexed by the physicist, it has become an astro-physics. Shall we say then that it has ceased to have a separate entity? By no means. It gives out its raw material to the mathematician and physicist, and takes it back enriched for its own development. Thereby it produces a most wonderful and perfect weaving of three scientific branches. It was the perfect beauty of this combination which had an alluring attraction for my father. It was fitting then that he should be professor of mathematics *and* astronomy.

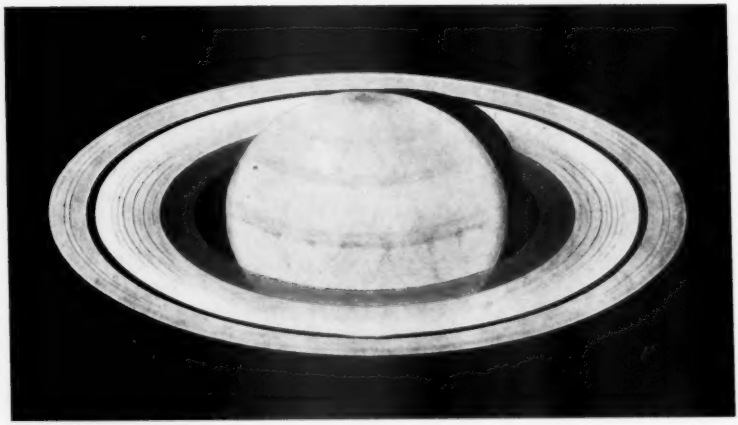
Yet, while this is true, his heart was in the astronomy. And why? Not alone nor chiefly because it was a combination of several sciences, but above all, I think, because of the manner in which it touches human thought and reveals Him whose abode is the light of setting and of rising suns. My father believed, as do many astronomers, that the greatest revolution ever made in human thought was that produced by the Copernican theory of the rotation of the planets about the sun. A like claim is sometimes made for Darwin's theory of evolution. With one stroke Darwin annihilated what men had conceived to be the infallible teaching of the Bible concerning the creation of the world and of man. For the fall of man he substituted the rise of man, for instantaneous perfect creation out of nothing he substituted ordered development and upward struggle. But great as was the change produced by what men termed in derision the Darwinian theory, its way was prepared by the Copernican theory and many another change in the four intervening centuries. For in Darwin's time there was freedom of thought. The scholar could say even as today, "*zu denken ist Gottes Dienst*"—to think is God's service. But the time of Copernicus was still the darkness of the middle ages. "Then the church had a rigid system of "dogma" and "philosophers a cast iron system of truth to match." The earth was the center of the universe. God sat on his throne in the upper story just above the clouds while hell was in the basement below. Copernicus burst forever these shackles of tradition and altered the entire conception of the world. More than this! While the later theory of Darwin leaves man on the topmost round of creation, in the universe of Copernicus he is abased into utter insignificance. Seen in the telescope even the sun and planets become as dust in the heavenly scales. The stupendous size of the universe hushes thought itself.

I doubt not that astronomy, like evolution, has made many an agnostic. It has made of man a Job vainly searching for an answer to the riddle of the universe. Can man by searching find out God? Yet, as has been so often said, an astronomer is reverent. As he scans the heavens night after night, a sense of harmony and reverence so fills his soul that agnosticism is forced out. "Hitch your wagon to the stars" is only a modern version of Isaiah's call "to lift up your eyes on high and behold who hath created these things." Astronomy is the foe of small thought. I do not know, I only wonder whether it was astronomy which developed in my father his great, his unusual love for truth, or whether it was his love for truth which drew him to astronomy. But this I do know, that its close connection with human thought was one of the reasons why he adored astronomy.

And there is another element in astronomy which made its strong appeal to my father, its romance. Every science has its romance, even mathematics, as I can testify. But is there another romancer such as the astronomer? His tales surpass the Arabian Nights in their appeal to the imagination. He crowds the pages of his science with wonderful stories of discovery and with startling surprises, and *these* myths can be believed by everydody.

Should not such a science as this be ever a popular and essential element of a college curriculum? Can any other science teach morals so unobtrusively? Has any other science an horizon so vast and ennobling? With the coming of Professor Slocum as Wesleyan's first professor of astronomy there opens here, I trust, a new era in which it will exist for its own sake. It is our wish and hope that my father's dream for astronomy and for the observatory may all be realized; for astronomy, that it may be an inspiring and much loved part of the curriculum; for the observatory, that it may be renowned for its research. My father entered not himself into this promised land. But for you, Professor Slocum, may these dreams come true.

PLATE XXV



SATURN—OPPOSITION 1914-15

From drawing made by Dr. Percival Lowell at the Lowell Observatory, Flagstaff, Arizona.

OUR SOLAR SYSTEM.*

PERCIVAL LOWELL.

Our solar system consists of a central ruling body, the Sun, around which circulate a number of smaller bodies called by the ancients "planets", which in greek means wanderers, because unlike the fixed stars they were seen rapidly to change their place. The study of this system is chiefly carried on at the present time by the observatory which I represent tonight. For today astronomy is largely specialized; observatories being stellar, solar, or planetary, as the case may be.

Of the origin of the system all we know is the birth-mark it bears of catastrophic origin, and that what we see today is the result of the shattered fragments coming together again. The proof of this lies in the telltale character of meteorites which are the *dei ex machina* in the matter. In a book called the Solar System, published many years ago, I pointed out a corollary from their character, to wit: That the fact that the meteorites held occluded gases which could only have got in under great heat and pressure; and that they had constituted the bricks from which our present system had been built, being themselves the left-overs, when considered together showed that a great disruption had preceded and furnished the material for the evolution of the solar system of today.

Of its career, subsequent to the collision or near-collision which gave it birth, we know only isolated bits. Many attempts have been made to decipher its history, but so far without scientific success. Thus Laplace's nebular hypothesis, which for many years in the early part of the last century had a great vogue, was long ago shown to be untenable. Faye in his "Origine du Monde" in 1884 exposed its fallacies and it was known to be in error long before that. Faye substituted a theory of his own and there have been many since, but we have no proof, and in several instances no reason to suppose, that any of them is correct. Scientists take little stock in such speculations, because of the lack of facts for basis.

* Lecture before the Chicago Academy of Sciences, April 25, 1916.

We have, however, ground for saying what it probably was not. It probably bore no analogy, still less any distinct resemblance, to another type of evolution which we see in the sky, that of the spiral nebulae. Recent research has pretty well convinced scientists that we are there envisaging something quite different. This is indicated by the enormous size of these aggregations as shown by their apparent lack of parallax, which means their enormous distance off; secondly by their tremendous speeds, discovered at Flagstaff by Dr. V. M. Slipher, and thirdly the still later discovery by the same astrophysicist of their equally enormous rotary velocities, spins of a different order of magnitude from those of our solar system. In fact all we know and all we are daily learning about them imply that they are galaxies themselves in process of forming republics of stars and not absolute monarchies like the system of the Sun.

Of certain parts of our own evolution we are, however, well assured. From once scattered congeries of small particles, gravity has condensed the matter composing it into discrete bodies, each at its own distance from the central ruler. Curious relations between their distances lead us to believe that the planets themselves have had a hand in the arrangement and that what we now see is no haphazard result, but due to the forces brought into play by the several bodies during the period of the system's fashioning.*

Their several sizes are due first to the amount of matter originally at their disposal and secondly to the amount they were permitted to collect by the action of their neighbors. Their sizes once settled had in turn a determining effect upon their subsequent careers. Heated as these bodies were by the coming together of their meteoric constituents and their consequent contraction, the larger would necessarily take longer to cool and thus protract their life-histories. They evidence this, every one of them, today, complicated of course by other factors.

In this family our Earth holds a middle position in size and in relative age. It is now cool on the surface though still enormously hot within. The latter fact is proved by the increase of heat as we bore into it, and from the inevitable deduction that the gradient must continue to the centre; for by conduction the heat must spread in all directions and could not flow out to its full capacity until a down gradient to the surface were established from the core. From the necessity of this gradient we see that the process of accretion was not intermittent after the body had begun to cool, but took place practically once for all, long ago, while the body was still universally hot.

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* The Origin of the Planets. Memoirs of The American Academy of Arts and Sciences. Vol. XIV—No. 1.

Study of the system today makes this certain. There are no large masses of meteorites vagrant now and from continuity of process cannot have been for an excessive past. Glacial effects were local and are best explained by local elevations of the crust.

Principles acting continuously are our only trustworthy guides in science. As an example of the wisdom of pinning one's faith to general laws, I may take the case of Mercury. In the old textbooks, in Young's for instance, Mercury was described as the densest of the planets. Twenty years ago this struck me as theoretically impossible, since the smaller the body the less necessarily its self-pressure. Study of the planet by daylight showed in what the error lay, its diameter measured against the sky coming out decidedly bigger than the received one and search revealed that the older measures had been made on the body in transit—the sky-method having been at the average observatory impossible—and no account taken of the loss in the apparent diameter through the sun's irradiation into it. (About the same time its mass was slightly revised.) With the new diameter the density came out in strict accordance with the pressure law.

In none of its many branches has astronomy made greater strides in the last half-century, than in knowledge of the planets. So revelatory have been these discoveries as to introduce us to a new order of acquaintance with these bodies.

Flagstaff was specially selected as a site for such study because of the excellence of its planetary images. Far from the smoke of men it enjoys a climate which renders its air steadier than any so far found in the United States. This permits not only the detection of detail invisible elsewhere, but a precision of measurement of the detail detected, necessary to any accurate deductions from it. In consequence the art of observation has there been studied carefully, to the revealing of atmospheric and of optical conditions which, if not duly reckoned with, are pitfalls to precise results. Thus, simply to name one point, irradiation, till then left out of account in planetary measures, has there been shown to be vital to exactness.

To speak of all the planets would overrun the bounds of your endurance and of my time. I shall, therefore, confine myself to two, Saturn and Mars; the one typifying an early stage in planetary history, the other a far-advanced one. Compared with our Earth, Mars represents a cooler and relatively older world; Saturn a hotter and younger beginnings of one. Both planets are interesting as pointing in a general way to what our career was and to what it will attain. Saturn indicates, though with important differences, what we were; Mars points out with like foreshadowing what we shall become. This is one

reason why Mars is to most of us the more interesting of the two. He is the future embodied, not the past revived. For the average person is more concerned with his coming track than he is over his wake. Furthermore we see in him the workings of physical laws in a field not too unlike our own, but freed from much of the complexity they are involved in on earth and decipherable therefore with greater speed and certainty. Then, too, in its evolutionary career a planet develops up, not down. With age it evolves higher and higher forms of chemic combination, ending finally in what we call life. Mars permits us in deciphering himself to read in advance a chapter in store for us in the great riddle of the universe.

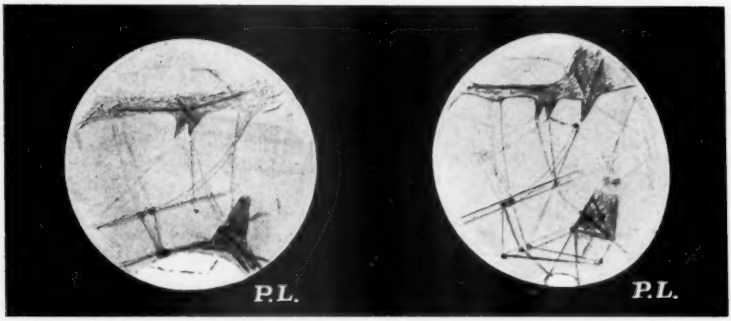
The two pictures I shall present to you are not exactly presentments of our particular career—for size greatly alters a body's cosmic course. A large body and a little one have not the same life-histories. But if absolute similarity be wanting, the very dissimilarities we note help us to a further comprehension of the cosmos and add a heightening interest of their own.

To a laymen probably the most impressive object in the heavens through a telescope is the planet Saturn. To see for the first time that great globe, girdled by its rings and set among a cortege of satellites, is a sensation as impressive as it is superb. Its light, its color and its symmetry all appeal instantly to the eye. The tiniest glass reveals it both beautiful and strange, while the largest does not exhaust its wonders. Thus quite a new order of detail has recently been discovered, both upon the ball itself and in the rings.

The first thing to catch the eye are the planet's belts. These are longitudinal stripes across the ball, suggesting broad natural parallels of latitude. They are easy to see and have long been known. When more minutely examined, however, they are found to be darker on the edges than in the centre, each thus appearing to be double. But the strangest of the ball's markings detected at Flagstaff are filamentous streaks between the belts, sometimes vertical but more often inclined, after the manner of the lacings of a sail. Individually they resemble distant droppings of rain from a storm cloud seen slanting against the sky under the force of a strong wind. At first they were described only across the light equatorial zone, but have since been seen meshing the whole surface of the disk. Were they not so faint they would yield excellent departure points for timing the rotation periods of different latitudes. For what we see of Saturn is not solid substance but a gaseous chaos in which each part is engaged in a go-as-you-please race with its neighbors.

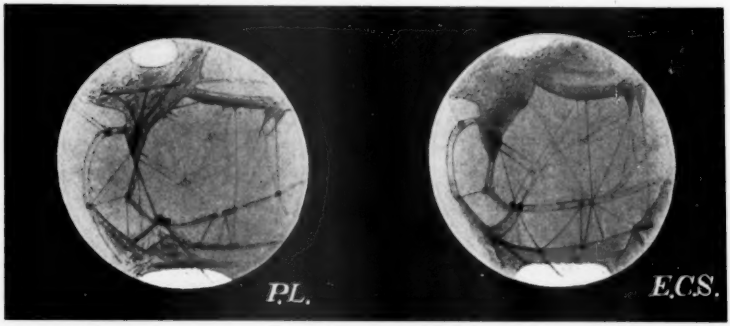
These wisps are not mere Saturnian oddities; they have a cosmic

PLATE XXVI



January 28 April 9

Rifts in snow cap where canals later appeared.



March 6 March 11

MARS IN 1916

From drawings made at the Lowell Observatory.

origin and intent. For they are found also upon Jupiter, which is in a similar stage of planetary evolution. Like the belts they are products of the axial rotation and of motions within the mass; only more intricately so. Why they are we do not yet know; that they are is evidently a necessary corollary of the forces at work.

Along the equator runs a narrow dark chord, like an outward visible sign of the dividing line where the forces reverse. This, too, is a cosmic feature, for Jupiter is similarly girdled. In fact, the surface markings of the one planet are a near-replica of the other's.

In its rings Saturn is unique. That the particles, meteorites, composing it are so close to the planet—within Roche's limit of the ball—prevents their coalescing into a satellite; the differential pull of the planet there exceeding the particles' own attractions for one another, so that they are pulled apart more than they are drawn together.

This appanage is not a single flat ring, but is made up of a great many narrow ones of different densities and different brightness, according as the particles are more crowded together. Outside of the outer one, circles the tiny satellite Mimas like a faithful watchdog guarding a herd of sheep. The simile is more than a figure of speech. For this diminutive body has actually caused the particles to arrange themselves in the several distinct rings. Furthermore, he has apportioned the numbers now found in each. He has in fact driven the rings into taking the form they present. When we compare his tiny twinkle with the broad expanse of splendor of the rings, such sway seems like the triumph of mind over matter. It more nearly represents the combined action of the particles of his mass against the lack of unity of the particles of the rings. For in a sphere all the particles act like a unit at the centre. It is the force of an army as against a mob.

In the case of two bodies disturbing one another as they travel round a third, the resulting effect is greatest when their meetings or conjunction take place recurrently at the same spot. This is because in such circumstance, whatever effect is produced is repeated over and over again—and, being cumulative, ends by being very large. The action may be seen in the case of an ordinary swing. If little pushes be applied rythmically at the same point of the path the swing rises higher and higher; if at all points indifferently, the pushes counterbalance one another to a nullity.

Now such similarly situated meetings will occur if the two planets have periods which are commensurate with one another, as 1 to 2 or 2 to 3. In such circumstances the disturbance grows until it ends in changing the periods of both so that they are no longer commensurate. In other words no planet will allow another to travel where its

period would be a vulgar fraction of its own. Analytically the perturbing function is expressed in a series of periodic terms in the orders of the masses, m, m^2, etc. Now it is a property of the squares that they are necessarily plus, and therefore, contain constant terms. One of these constant terms changes permanently the mean motions, thus forever preventing fractional synchronism of period.

Now it is just where a particle of the rings would have a period commensurate with that of Mimas, that no particle is found, thus causing a division. All the important ratios are thus visibly sculptured into the form of the rings, featured in proportion as the force is strong.

Saturn and his suite are thus the embodiment of the laws of celestial mechanics in an early stage of planetary history. How beautiful their action, the sight of Saturn shows. It represents the apotheosis of mathematical form and yet the outcome of nature's simplest law, that of universal gravitation.

Quite another order of interest attaches to the second planet, the planet Mars. In it we find ourselves gazing at almost the antithesis of Saturn. Instead of a thick cloud canopy covering a seething mass below, we perceive a solid surface lying unveiled to view beneath a thin perfectly transparent air. We see it clearly revealed, far better than it ever can see us; the only bar to absolute definition being at times our own atmosphere, which in most places obscures, if it does not hide, what is certainly the most astounding sight in the heavens, the visible signs of intelligence upon another world. That the Martians should be led to doubt our own would be but natural, for our earth viewed from without presents even less evidence of mind than when considered more intimately from within. Nothing of men's handiwork would be visible to an observer placed on Mars. Our cities would shrink to nought, our railway lines be lost, everything revealing thought be swallowed up by distance. He might, perhaps, view the effects of our change of seasons but beyond that nothing.—Man's presence would lie unsuspected.

Quite otherwise is the aspect of Mars. Owing to its thin air it is possible in certain favored localities on Earth to see what is there going on. And that a great deal is going on is evident. Over a geography not unakin to the Earth's, is spread a mesh of lines and dots like a lady's veil. Only in this is it unlike that instead of hiding recognition the veil reveals it. For by its striking geometricism, it at once suggests artificiality and taken in connection with recent research as to the planet's physical condition implies local directing mind.

This network has been universally confirmed by students of the subject suitably equipped with instrument, eye and atmosphere and has been recorded on thousands of photographs.

To show what these photographs reveal to an acute-eyed observer not otherwise connected with them, there is here presented a drawing of the markings visible on the latest of them, that of March 15, 1916 The drawing was made by Mr. G. B. Hamilton, M. A. of Cambridge, England, F. R. A. S. and at one time assistant in the University Observatory, Oxford. It depicts 39 canals and 16 oases, the former as fine lines, the latter as dots, both presenting the same stamp of artificiality they display to the eye, when due regard is paid to the limit of precision imposed by the grain of the plate. Lack of a knowledge of photography alone is responsible for any failure to see them as geometric lines by inducing the observer, in hopes to see them better, to magnify them too curiously with a glass, to the obliteration of everything but the grain. It is then a case of not seeing the wood for the trees. Nothing perhaps better points the truth of the French aphorism—"Better is the enemy of good." To view them well, one should regard them with the eye of youth as they are presented on the plates, when their linear character and fineness will start to his vision at once. That photography should be able to record such delicacy of detail is certainly marvellous, with the planet at the time 75,000,000 miles away.

A prevalent misconception, largely bruited in not-expert writing on Mars, is that his near oppositions are best suited to detection of his canals. This is an example of the little learning that is so dangerous a thing, for the facts are largely the reverse. Were other things equal, when Mars is nearest the earth, he would be best seen. But other circumstances are not equal; for it so happens that the earthward presentations of the hemisphere where and of the season when the canals are most visible, occur together during his far approaches. Persons not conversant with the planet though very conversant about it, neglect those opportunities, devoting their efforts to the near and difficult oppositions.

The opposition which has just taken place has been one of these generally neglected but revelatory occasions. Several interesting phenomena have disclosed themselves on the planet's surface; some strikingly corroborative of what we already knew, some new which were unsuspected before.

Of the first class has been the evident consequence of the canal development upon the melting of the polar snow. This dependence has been markedly displayed during the last few months. It was just the Martian season to show it and the planet's surface has presented it to us. On October 18, 1915, the date of the planet's vernal equinox of the northern hemisphere, the northern snowcap was very large, coming down to latitude 60°, or thereabouts. Only right near its edge

were any markings conspicuously dark. By January 1, 1916, the Martian date being April 25, the cap was in active process of melting and the north temperate canals were dark while those in the north tropical and equatorial regions were almost invisible. Two months later, a month in Martian chronology, these latter had begun to stand out. The seasonal change in them is well shown on comparison of two drawings, the one made on January 28 and the other on March 2, the former depicting Aeria as an almost unbroken stretch of ochre desert, the latter recording it as traversed by the faint beginnings of the great double canals for which it is famous.

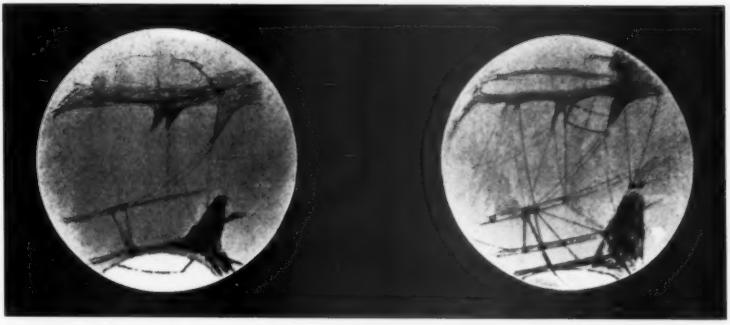
At the same time the canals in the dark regions of the southern hemisphere had been fading out and the Mare Tyrrhenum had turned to a chocolate tint, in contrast to the blue-green hue it had worn before.

And yet during this interval the planet had been getting farther away from us so that, had no intrinsic change affected the markings, they should have been less, not more, salient than before. Thus nature obligingly removed any possible doubt of the real accentuation in them while at the same time it offered, in the southern dark regions, a background on which to judge of their canals' obliteration, the more so that those regions themselves were fading out and were so wide that distance had no effect upon their general evidence.

Such canal development upon the melting polar snows was precisely what the theory framed here of the planet's present state had predicted.

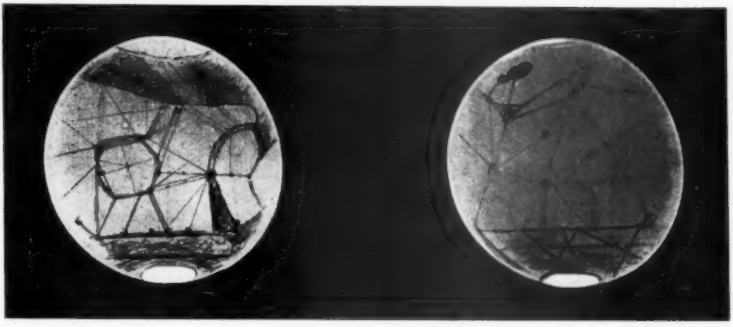
Of the second set of phenomena, those never before sufficiently seen to be properly appreciated, was the detection of a set of markings so minute as to constitute a new order of Martian features. Though individual instances of these remarkable showings had been previously detected here, they were not numerous enough to disclose their generic character. Spun, as it were, across the areolas of the planet's surface, made by the intersection of the main canals, appeared what may be likened to spider webs with the spider itself at the centre. For in several of the canal-bounded polygons a diminutive dot appeared, roughly speaking, in the center of the space, from which stretched filaments binding it to a corner and to the sides of the areola. Curiously enough the southeast thread, that joining the dot to the corner was the most salient of these ligatures and therefore the one detected first, though apparently it was no longer than the ones going to the sides. This web upon a web was first descried in Elysium and subsequently in Arcadia, while the Fons Juventae with its spokes proved to be of like character. To symbolize their peculiarity and position, the distinctive word Fons has been given them. Thus there is the Fons Immortalis in Elysium and the recent Fons Senectutis in Arcadia. While the

PLATE XXVII



January 28 March 2

Showing Canal Development.



March 15 March 27

Showing the new order of markings.

MARS IN 1916

From drawings made at the Lowell Observatory.

spokes are called Viae, as the Via Vitae leading to the Fons Senectutis, and the Via Eterna to the Fons Immortalis.

So tenuous are these spoke-like filaments that they usually first appear as straightly aligned fine beads, becoming continuous lines only on still better seeing. The seeming beads are very small, finer than the Fontes which are themselves very minute, being only about ⅓ the diameter of the usual oases. The usual oasis, as near as may be judged, is about a degree of Mars or 35 miles across; so that a breadth of 10 miles for the Fontes is probably an outside limit. What they are we do not know. But that they are important points in the intelligent life of the planet is evident. For we should be careful not to assert more than science can affirm. All we can say at present is that the spot is clearly some sort of goal, the spokes pointing it out as an objective; while the lines to it differ in intent from the system of great canals which are through lines of communication.

Other detections of the last few months might be mentioned but I have said enough to show how our knowledge of Mars steadily progresses. Each opposition as it comes round adds something to what we knew before. It adds without subtracting. For since the theory of intelligent life on the planet was first enunciated 21 years ago, every new fact discovered has been found to be accordant with it. Not a single thing has been detected which it does not explain. This is really a remarkable record for a theory. It has, of course, met the fate of any new idea, which has both the fortune and the misfortune to be ahead of the times and has risen above it. New facts have but buttressed the old, while every year adds to the number of those who have seen the evidence for themselves. Astronomy is successive evolution simultaneously shown. In this brief sketch of bits of planetory history we have considered but two links in the long chain, one near the beginning, the other toward the end.

THE HISTORY OF THE DISCOVERY OF THE SOLAR SPOTS.

WALTER M. MITCHELL.

[*Continued from page 354.*]

The apparent depression of the spots, which many years later gave rise to the famous Wilsonian hypothesis and its resulting controversy, evidently occupied a great deal of Scheiner's attention and time, for he refers to it many times in his great work. Von Braunmühl asserts* that Scheiner had already observed the apparent depression of the spots, and that he should be credited with the discovery of this phenomenon instead of Wilson. But Carrara† and Schreiber‡ show that this is an error. It is true that Scheiner speaks of the "depth" of the spots, but further investigation will show that the depth referred to, means thickness, and not depression. Scheiner frequently expresses himself with considerable uncertainty on this question, but this is doubtless because he was endeavoring to make his statements agree with the observations, which were themselves contradictory. Sometimes one may think that he considers the spots as elevations, other times he refers to the spots as depressions. But if one collects all the statements together and has regard for his terminology, and considers whether he is referring to the spot as a whole or only to the nucleus, the intent is evidently the following:

1. The spots certainly are not depressions in the sense of cavities or holes.¶

> The body of the spots are not dark depressions, fissures, gaps or dark openings.

At another place,‖ he states that the spots appear to be holes in the luminous surface through which we sometimes view the dark body of the sun. He then wonders, if such is the case, why it is, that the darkness is not illuminated by the surroundings which are bright; also why the faculae generally follow the spots instead of uniting over them. Further, at their entrance and exit (on the disk) the spots ought to be completely hidden by the surrounding faculae.

* *Op. cit.* p. 63.
† *Op. cit.* 24, 75.
‡ *Op. cit.* p. 88.
¶ *Rosa Ursina*, p. 510.
‖ *Ibid*, p. 500.

2. Scheiner believed that the observations would be best satisfied if it were assumed that the spots were situated at the level of the sun's surface. If his views are collected, one will find that he believed that the spots were definite material bodies or masses, of greater density than the surrounding medium in which they were imbedded, and which Scheiner believed to be of the nature of a fluid.*

> The body of the spot consists of a solid [that is, as he himself states, three dimensional] dark, opaque body, which projects at the most only slightly beyond the luminous surface of the sun.

He remarks† that in virtue of their mass the spots have a real depth, that is, extend under the surface. Concerning this surface he writes:‡

> I do not place the spots at such a depth [in this surface] that they are entirely immersed; for one spot may project more or less than the others, just as all ships in the sea do not sink to the same depth. For this reason, I always state that the spots are found on the physical surface of the sun, which is not to be considered as a mathematical surface, devoid of thickness, but as a surface possessing a real thickness, in which, and by which, the spots are carried by the rotation.

Regarding the projection of the spots beyond the surface:¶

> It is readily apparent that most of the spots project at least slightly beyond their surroundings, for, on account of their positions they obscure the luminous spaces between them when near the limb, so that two, three or more appear as one, which would not be possible if they did not project somewhat beyond the surface. I say that most of the spots, for sometimes large ones are suddenly overwhelmed with light before they reach the limb so that they can no longer be seen, and instances of this kind offer a strong argument for the opposite view, for one cannot easily assume that they always physically dissolve, but instead is forced to the opinion that they have sunken all at once in the luminous ocean. There can be no doubt that such spots lie deeper in the luminous surface, or that the latter is more elevated.

In another place we find:‖

> The exterior surface of the spots is hence very much compressed and nearly flat.
>
> From the observations themselves, up to now, we have shown that the convex surface of the spots projects toward us hardly a sufficient amount to permit us to observe their elevation beyond the circular edge of the sun.§

Further, Scheiner believed that for circular spots the curvature is approximately spherical, but different from those that are not regular.

3. Scheiner believed that in contrast to the penumbra the nucleus lay at a lower level than it. He remarks** that it is

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* *Ibid.* p. 510.
† *Ibid.* p. 485.
‡ *Ibid.* p. 551.
¶ *Ibid.* p. 511.
‖ *Ibid.* p. 484.
§ *Ibid.* p. 493.
** *Ibid.* p. 505.

Wholly submerged in the penumbra, both as regards all its dimensions and the whole of its mass.

The nucleus was a real body to him,—not an empty hole—and this body extended deeper than the "less dense body" of the penumbra. Scheiner believed that the penumbra extended somewhat like an arch over the surface of the sun, and that the nucleus was similarly convex, and sufficiently so, that in spite of its deeper position it could still be seen when the spot was near the limb.

Although Scheiner never in so many words explicitly upheld the theory subsequently advanced by Wilson, and as he only expresses himself with hesitation, neither can it be said that he directly opposed it. He sometimes places the nucleus at a lower level than the penumbra, but then only slightly lower, and this only for occasional spots. He considers it an established fact that:

..... at a position near the limb, the spot presents to our eyes that portion of its penumbra which lies between the observer and the nucleus, and which cannot be distinguished from the nucleus, until by its motion the spot is optically extended and is seen in its full length.*

This is directly opposed to the Wilson hypothesis. At the limb a fairly regular spot appears like a line parallel to the limb, or even as a segment of it.

From this phenomenon it follows that the exterior surface of the spot does not differ greatly in curvature from that of the solar surface itself .... otherwise it would appear distorted.†

The doubtfulness with which Scheiner expressed himself in discussing whether the spots are depressions or not, indicates one thing at all events, namely, the careful and painstaking manner with which he made his observations. Similarly it indicates the caution which he exercised when refraining from making assertions which could not always be supported by the evidence of the observations. If we regard the conflicting observations which have since been made by so many astronomers, and the controversy which waged for many years, we will no longer wonder that Scheiner was puzzled and became hopelessly confused in attempting to formulate a theory which would agree with the observations.

Johann Fabricius seems to have been the first to have mentioned the penumbra, but it was evidently seen indistinctly by him. Scheiner, however, was the first to give an accurate description of it. Long before the publication of the *Rosa Ursina*, in the letter of January 16, 1612, addressed to Welser, he writes:‡

* *Ibid.* p. 501.

† *Ibid.* p. 482.

‡ *Gal. Op.* **5**, 48.

The boundary of all the spots is rough, as if surrounded with little fibers of white and black; and the majority of the spots are brighter about their borders than in the center.

That Galileo had also noticed the penumbra at an early date is clearly indicated by a remark in the first letter to Welser:*

They [the spots] easily change their shapes, which in certain parts are more dark and opaque; and in others are less so.

In the drawing which accompanies this letter the penumbra is clearly shown as a shaded region surrounding the nucleus of the spot.

But as might be assumed, the *Rosa Ursina* contains the greater amount of material descriptive of the different portions of the spot. Some of Scheiner's remarks will be of interest. He writes:†

I have found three kinds of spots, one kind have nuclei, and indeed they are very distinct; the other kinds, excluding the nuclei, resemble vapors, or fog, or smoke.

Every spot is provided with a nucleus, which is surrounded by a definite body less dark and brighter than the nucleus itself.‡

The border or boundary of the spot is neither continuous nor uniform, nor sharply defined; but instead it is varying, rough, broken and gradually disappearing; at the place where it meets the bright surface it appears as if fringed by the mingling of bright and dark from each side. Indeed certain spots appear from time to time whose borders remain the same while the spot is visible, as is the case, for instance, with circular spots. Since however, this very seldom occurs, and then only as long as the spot remains in a condition of quiet, one must judge from the usual appearance.....This much, however, remains fixed; the borders always appear like contours or line drawings, either curved or straight, or both combined.....always rough, jagged, indented, as if woven with fine threads: and moreover this phenomenon never remains the same in appearance or position, or form, but always shows the greatest variations.¶

This detailed and comprehensive description will doubtless be subscribed to by every astronomer who has observed the surface of the sun. One realizes from Scheiner's descriptions that his instruments were not as deficient in defining power as one might have supposed; and that the sun-spots appeared to Scheiner's eyes much the same as they appear to our own. Regarding the relative positions of umbra and penumbra, Scheiner remarks as follows:‖

The exterior border of the penumbra agrees with the position and aspect of the nucleus, so that when the nucleus increases in one direction, the penumbra also increases in that direction, but always with the peculiarity that the penumbra increases toward the east rather than toward the west; so that sometimes the nucleus pushes itself out toward the west almost entirely denuded.

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* *Gal. Op.* **5**, 106.
† *Rosa Ursina*, p. 156.
‡ *Ibid.* p. 510.
¶ *Ibid.* p. 513.
‖ *Ibid.* p. 210.

The fact that the nucleus is not always centrally placed in the penumbra, did not escape Scheiner, as is evident from his remarks. He further states:*

> The nucleus is not always placed accurately in the center of the spot, as I have already remarked; instead it is sometimes to one side. The body of the spot advances with its western edge before, so that it simultaneously trails after it the lighter portions of the spot.

This remark informs us that Scheiner perceived not only that the nucleus was sometimes eccentrically placed, but also that the nucleus of the spot tends to advance (in the direction of the sun's rotation) trailing after it the penumbra and the smaller "spotlets"; a fact of which all solar observers are aware. This tendency Scheiner noticed particularly in spot groups.†

> Seldom does a large spot appear alone, which, for a time at least, is unaccompanied by other spots; these often precede, but more frequently follow it.
>
> The nucleus strives and strains toward the west, which is customary with large spots.‡

Of even greater interest to Scheiner was the manner of formation and disappearance of the spots. Here we find that Scheiner was nearly as well acquainted with the life history of the average spot, as are his successors among the Jesuit astronomers of today. The process of spot disappearance received more attention than did that of spot formation; this was the obvious result of the ease with which the disappearance could be observed as compared with the inconspicuous beginning. He describes the manner of formation thus:¶

> After I learned this [the manner of disappearance], I began also to investigate the formation of the spots and found great similarity between their formation and disappearance. For I perceived for newly forming spots, as if it were premonitory, very fine shadings like cobwebs, spread over the sun's surface, which were only visible when one moved the telescope. In the course of a few days these shadings gradually became denser, developed into spots and remained constant. On this account I am accustomed at the beginning of each observation to examine the whole sun, moving the telescope while so doing. If I should notice such a shading, which seems to indicate a spot, I determine its position, magnitude, and appearance, recording also whether it is thin or dense, regular or irregular. In this manner I can be assured of observing the beginnings of many spots, although I acknowledge I sometimes stumble on secondary spots .....I found in a similar manner that small spots separated from each other, broke out like blisters, gradually widened and united into a whole, increased in size, remained constant for a time, then decreased and in a similar manner disappeared.

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* *Ibid.* p. 49₁.
† *Ibid.* p. 516.
‡ *Ibid.* p. 260.
¶ *Ibid.* p. 536-537.

Regarding the development of the nucleus, Scheiner writes:*

Frequently one single nucleus develops from the many small separated nuclei of a large spot; not by running together or local commingling of the single spots, for their centers retain their mutual distances, but through the intervening spaces becoming filled with similar material [to the umbra] or through increase in size without change of position.

Similarly two or more small nuclei develop from one large spot, not through local displacements of the individual parts, but through a sort of vanishing of the material between them.

Some spots at first show certain small, indeed diminutive, signs of their existence, as if they had come up from the depths of the sun; very faint at first, they gradually increase in size and density, and when they have attained the appearance of a spot, they become darker in the middle and the beginnings of the nucleus are seen, which then increases like the whole spot. Sometimes, however, many little spots move forward at the same time, but gradually; sometimes they rapidly melt into one spot and immediately develop a nucleus.

In similar detail Scheiner describes the disappearance of the spots.†

Many spots decrease in size and at the same time undergo a diminution of density, so that only a delicate shadow remains, which differs so little from the rest of the sun's surface that it can be noticed only when moving the telescope, and such dark traces remain sometimes for one or two days, but more often they soon vanish completely. And indeed, a facula is frequently seen at the place; many times none is seen. In short, if one were not sure that a sun spot had been at this place, he would certainly not risk asserting that this phenomenon was the last trace of one.

Scheiner describes the small variations in the process of dissolution which he had witnessed, and continues:‡

Finally many spots appear to be gradually inundated by luminous material from all sides, the luminous material spreads itself out, the spot decreases in size until no trace of a shadow remains, and only a bright facula is seen .....This manner of dissolution is very frequent, and differs from the first, as follows: in the first case the darkness of the spot gradually decreases.....but in the second, the inundating luminous material hides the whole spot from sight, even if it may have a large and well defined nucleus, until all the darkness has disappeared, and only a bright facula remains.¶

One point is of particular interest, for it shows the care with which Scheiner made his observations; it has also occasioned some discussion among latter day astronomers. Scheiner maintains on the evidence of many observations‖ that faculae frequently succeed spots and spots again succeed faculae at the same place on the sun's surface. He

* *Ibid.* p. 498.

† *Ibid.* p. 535.

‡ *Loc. cit.*

¶ According to Scheiner's observations these faculae are distinctly larger than the original spot whose position the occupy.

‖ *Ibid.* p. 230.

also noticed that spots occasionally reappeared at the same place, and in a particular instance remarks that this "is not an unusual occurrence with other spots."* Briefly, one finds that the facts regarding the growth and decay of the sun-spots, which we have learned with our improved modern apparatus, were also known for the greater part to Scheiner, who described them with great detail and skill, citing numerous observations as evidence.

The question of the duration of the spots also occupied Scheiner's attention. It appears that he believed that no spot endured for more than two months,† which seems peculiar, for he mentions spots which apparently were visible for more than two rotations. Three periods were distinguished in the life history of a spot. 1. From the first appearance to full growth. 2. The constant state, or period of apparent quiescence. 3. The period of dissolution or decay. The results of Scheiner's observations regarding these periods are as follows:‡ Although the duration of the constant state is very variable, in general it is proportional to the period of growth; that is, a spot which appears very suddenly does not long remain in the quiescent state, but progresses rapidly to disappearance. To this, however, there are exceptions. The disappearance or decay usually progresses gradually, but may vary considerably; in general, however, the period from full development to final disappearance is about twice as long as the period of growth. The size which the spot may attain has no relation to the time required for development.

The observations of the longest enduring spots are of interest.¶ At the time of the earlier observations the question had occurred to Scheiner, whether or not a spot might sometimes become visible a second time because of the sun's rotation. It was evident that many fully developed spots passed beyond the limb without undergoing any extensive changes, or otherwise indicating immediate decay. Scheiner believed that it would be difficult to prove the identity of a spot, even if it should return. At that time, not being fully cognizant of the law of the sun's rotation, he wisely concluded to wait until more evidence could be obtained, judging that this would be the safer course. Scheiner showed his wisdom in waiting many years before expressing himself in this regard. He mentions instances of four spots which were visible for two rotations, to show by their aid what criterion should be followed in investigating such spots. He correctly placed small confidence in the mere appearance of the spot, but made the proof of identity rest

* *Ibid.* p. 264.
† *Ibid.* p. 592.
‡ *Ibid.* p. 490.
¶ *Ibid.* p. 546.

on the position of the spot on the sun's surface, and on the interval between disappearance and reappearance. While employing this method of identification he by no means overlooked the possibility of a spot disappearing when on the other side of the sun, with the immediate appearance of another spot at the same place. He remarks concerning the improbability of this, as follows:*

> It is inconceivable, not to say impossible, that this spot recently appeared at the place of a former one, which must have vanished. For that one passed off the limb while in a state of development, while this one appeared at the limb in a state of decay.

At another place he argues,† that if it were a new spot, a very large and extended spot must suddenly have disappeared, and another developed very suddenly in the same place, remaining afterward for a long time, "which is contrary to all experience."

Thanks to the accurate determinations of the positions of the spots, Scheiner was able to recognize the individual, or so-called "proper motions" of the spots, and to perceive that these motions had no connection with the general motion produced by the sun's rotation. Schreiber‡ asserts that Scheiner was the first to mention these motions in his *Rosa Ursina*. This seems to be an error. There is no question but that Scheiner discussed these motions very completely, and mentioned numerous instances of them among his published observations, but it is equally certain that Galileo had at an early date perceived precisely the same thing. At the beginning of the second letter to Welser, describing the phenomena of the spots in general, Galileo writes:¶

> Besides these irregular and individual motions of uniting and separating..... they have a common and universal movement.....

Scheiner measured these proper motions, determining their magnitude and direction. Of the motions in longitude he cites many instances, which are completely described and illustrated in the drawings. He repeatedly mentions:‖ "the increase in the distance between two spots on the same parallel." That there should be no doubt of the reality of this, he remarks in another instance:§ "with this in view I gave the matter great attention." In a very much disturbed group two spots separated in a manner: "absolutely unbelievable." In discussing two

* *Ibid.* p. 206.
† *Ibid.* p. 216.
‡ *Op. cit.* p. 154.
¶ *Gal. Op.* 5, 117.
‖ *Rosa Ursina*, p. 188.
§ *Ibid.* p. 184.

spots visible during April 1626, he remarks: "Their paths were nearly in the same parallel, and their mutual distance remained constant (which is very unusual in this phenomenon)."

The tendency of two sun-spots to separate, as if mutually repellant, which is generally supposed to be a more recent discovery, is thus seen to have been well known to Scheiner. He states it as a general rule:*

> The spots at their beginning are always closer together, and only later do they begin to separate from each other.

He again asserts in the discussion of the observations of a spot seen March 1625:†

> It is noteworthy (a fact which I have often remarked) that the spots at first are only separated by a small distance, which increases day by day, so that at the time of their disappearance the intervening space has not returned to its size at the beginning.

Displacements in latitude were also noted. He mentions many instances; in one such he states;‡ "Similar phenomena, namely, convergence and divergence of the paths of two sun-spots are often seen." Two spots, whose paths actually crossed he considered;¶ "an unusual but not unique occurrence."

Of greater interest are the discovery and observations of the faculae. It is asserted by von Braunmühl,‖ by Schreiber,§ and even by Favaro that Scheiner was the first to observe the faculae. Carrara, however, has shown in a most convincing manner** that this is an error which may be traced to the incorrect translation of a certain passage in Scheiner's letter of January 16th to Welser. It is true that in this letter the word "faculae" is used, but as Carrara shows, it is with an entirely different meaning from that which it has today. To Galileo unquestionably belongs the credit for first observing the faculae. In the third letter to Welser (dated December 1st, 1612) we find these words:††

> In the face of the sun itself there are sometimes seen certain small regions which are brighter than the rest.....and I believe that no one can doubt that these are in the sun itself, it being incredible that outside of the sun there should be found any substance more luminous than itself.

According to Carrara, Scheiner's first mention of the faculae as such is in the *Rosa Ursina*‡‡ where he relates the circumstances of an observation made on the 21st of December 1624, as follows:

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* *Ibid.* p. 294.
† *Ibid.* p. 188.
‡ *Ibid.* p. 330.
¶ *Ibid.* p. 264.
‖ *Op. cit.* p. 17.
§ *Op. cit.* p. 156.
** *Op. cit.* **24**, 80.
†† *Gal. Op.* **5**, 219.
‡‡ Page 163.

I and R. P. Ioannes Baptista Staserius, at that time a mathematician of Naples, the sky being most clear, examining the sun most carefully by moving the telescope, found it free from spots, but dotted with brighter regions which I call "faculae."

Carrara expresses surprise that Scheiner had not observed the faculae before this date, and discusses at length the probable reasons. However, if we can believe the testimony of Welser, Carrara is in error on this point. There is preserved a letter from Welser to Galileo, dated October 18, 1613, in which is quoted a portion of a letter, evidently from Scheiner mentioning and describing the faculae. Welser writes as follows:*

Since you like to hear of the discourses of my friend [Scheiner?], I copy what I have recently received from him concerning some new observations.

Welser then quotes as follows:

Since you ask of me what phenomena I have recently seen in the sun, there is no reason why I should refuse your friendly and just request. I add, therefore, an observation [a drawing which is reproduced in *Gal. Op.*] made on the first day of August, in which you will see examples of this new sight. However, these are not sun-spots, but are "little torches" (faculae), that is, regions which are brighter than those surrounding them, so that they shine more brilliantly than these.....Nor is there any reason to doubt at all concerning this thing, for I have noticed its appearance for more than a year; first, by inspection, then much more clearly by projecting with a tube on a card. Many other people unskilled in this thing saw it with me also.

The letter continues, describing the experiments that were made with the telescope and card to prove that the faculae were not caused by the apparatus. Scheiner then remarks:

They appear more rarely and less often than the spots themselves, and indeed, they are only visible at the margin of the sun, at ingress and exit, and then for a space of three or four days, but never in the middle [of the disk.] They are seen with difficulty, and only with a very good tube, and by moving the sun's image when on a card. Other things they have in common with the spots. What they are, I do not know.

There is nothing to inform us from what writing of Scheiner's this is quoted, but it seems safe to assume that it is from a letter to Welser, all traces of which, however, seem to be lost, for there is no other mention of it. If the statement of Scheiner, that he had been observing the faculae for a year, were true, it would place his observation as early, if not earlier than Galileo's. But as this depends upon Scheiner's statement alone, with no other evidence, it can hardly be considered an established fact. But there is no doubt that Scheiner had observed

* *Gal. Op.* **11**, 587.

the faculae previous to the date mentioned in the *Rosa Ursina*. Whatever credit may be attached to the introduction of the word "faculae" belongs to Scheiner.

If not actually the first to observe the faculae, Scheiner certainly observed them more carefully than did Galileo. Among the facts, which he ascertained as a result of his many observations, the following are worthy of mention.

1. The faculae are not confined to the spot zones. Numerous instances of this are given among his observations; he also states explicitly that the faculae are found in the high latitudes.*

2. The faculae are not all of the same brightness or intensity; many are very bright, intense, and brilliant, others are as if smoked or deadened. †

3. They differ greatly in size, oftentimes covering immense areas. The length of one group visible during April 1625 was equal to one-quarter of the sun's diameter.‡

4. The faculae show a tendency to spread out more toward the east limb than toward the west. Hence the faculae which appear in the neighborhood of spots generally follow them. This fact is repeatedly mentioned.¶ In every case there are more faculae in the rear of a spot than in front of it.‖

5. The faculae are subject to change even more than the spots.§ "This I have learned through accurate and continuous observations for many years."

6. The faculae move in accordance with the same laws as the spots. This is demonstrated from observations of faculae which accompany spots, as well as from those which do not. "That these were faculae, was deduced from the fact that the movement of rotation of the faculae and the spots is the same."** Scheiner established the identity of a group of faculae visible April 1625 on the east and west limbs, and from this determined their period of rotation.††

It was also established by Scheiner that faculae were frequently seen at the position of a spot after the latter had disappeared, and in other cases that the facula preceded the spot. Concerning the alternate repetition of spots and faculae at the same position, one needs only to

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* *Rosa Ursina*, pp. 190; 304.
† *Ibid.* p. 156.
‡ *Ibid.* p. 206.
¶ *Ibid.* pp. 248; 260; 268; 292.
‖ *Ibid.* p. 192.
§ *Ibid.* p. 202.
** *Ibid.* p. 190.
†† *Ibid.* p. 204.

examine the index of the *Rosa Ursina* under the titles, "Maculae in faculas abierunt," and "Maculis e faculis," to appreciate that Scheiner had repeatedly observed this. He collects the results of 27 observations and remarks,* that one observes:

> . ....the changing progression of faculae after spots and spots after faculae in the same place. I would not maintain this so eagerly for only a single observation if I had not found the truth of this to be most certain, and established by my own observations.

At an early date Scheiner had observed that the spots did not all move with the same velocity across the sun's disk. In the *Accuratior Disquisitio*† he describes the observations of two spots, one of which, crossing nearly on the ecliptic (through the center of the disk), required 16 days for its transit, while the other crossing farther from the center (as shown by a drawing) required only 14 days. Von Braunmühl states‡ that Scheiner had at this time observed that the spots near the solar equator travelled with a greater velocity than those further north or south, and hence, had discovered the "Equatorial Acceleration." In this von Braunmühl is believed to have made an error. In the *Accuratior Disquisitio* Scheiner remarks:

> This is certain, that those [spots] which transit the middle of the sun, delay more under the sun, than those which turn nearer the edges.....It is therefore manifest, that those spots which cross under the ecliptic—the sun's diameter—revolve longer under the sun than those whose path is farther away from it towards the south or towards the north. (Hoc certum, quae medium Solem transeunt, plus morae facere sub Sole iis quae magis ad extrema Solis vergunt.....Manifestum igitur, eas maculas quae Solis diametrum eclipticam subeunt, diutius sub eo, Sole inquam, versari, quam eas quarum via ab eadem sive in austrum sive in boream recedit).

From these observations, Scheiner argued that since the sun was *invariabile et duro posito* the spots could not be a part of it, no matter whether it rotated or not.

In his third letter to Welser, Galileo discusses this observation and resulting argument, and replies:¶

> Having made many careful observations of this thing, I have found not a single one from which we can draw any conclusion, except that all the spots indifferently remain on the solar disk for the same space of time, which in my opinion is something more than 14 days.

Galileo criticizes the observations of Apelles, because Apelles had observed not a single spot, but one spot of a large group, the relative

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* *Ibid.* p. 230.
† *Gal. Op.* 5, 49.
‡ *Op. cit.* p. 19.
¶ *Gal. Op.* 5, 203.

positions of which might change, and hence a single observation, which would be subject to many accidental errors, would not be sufficiently reliable to determine such an important conclusion. The irregular motions of the spots are such that no conclusion can be drawn except from the comparison of many observations. As a result of comparing over a hundred drawings and observations, Galileo states:

> I have indeed met with some slight differences in times of transit, but I have noticed on the other hand that the spots moving in paths near the center of the disk are sometimes more rapid than those further away.

From this it is seen, that if anyone is deserving of credit for the discovery of the equatorial acceleration at this time it is Galileo. However, he did not recognize that there was a systematic decrease in the rotation period with decreasing latitude, but merely noted in a few instances that the equatorial spots apparently travelled more rapidly.

Evidently Scheiner's many subsequent observations showed him the true state of affairs, for he informs us in the *Rosa Ursina** that different spots have different rotation periods, and that the spots at a distance from the equator travel more slowly than those nearer to it. By this time Scheiner had recognized that the spots were adherent to and a part of the sun, and that the assumption of a solid sun was no longer tenable. He states:†

> From this phenomenon is drawn the strongest argument for a fluid surface of the sun.

This extraordinary phenomenon—the equatorial acceleration—was subsequently rediscovered and observed by Carrington in 1859. Its cause still remains, as in Scheiner's day, one of the sun's unsolved mysteries.

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* Page 260.

† *Rosa Ursina*, p. 559.

EVIDENCES OF EROSION ON THE MOON.

WILLIAM H. PICKERING.

The question whether water formerly existed upon the moon in larger quantities than at present is usually answered in the affirmative, but generally for wholly erroneous reasons. We often hear it stated that the so-called seas are simply old ocean bottoms,—a most improbable view. A casual examination of the lunar surface shows that they were formed at a period subsequent to the creation of the larger craters, since we find numerous of these craters partially ruined and dissolved in them, evidences of fusion being everywhere visible. The seas really owe their existence without doubt to extensive fissure eruptions, such as have occurred in past ages in India and in some of our North-western States. During this period extensive areas of the Moon's crust sank beneath the liquid surface and were dissolved in it, much as often occurs at the present time on a small scale in Kilauea, Hawaii. The bottoms of the great majority of the larger craters were also dissolved or softened at this time, indicating that the crust was thin. After this period was over, a second era of volcanic activity began. The craters produced, however, were much smaller than those of the first period, and indeed are comparable in size to some of our own larger terrestrial craters. They are found chiefly upon the maria and smoother crater floors, and may be recognized by their dark color.

That there never was very much water on the moon's surface is rendered certain by the lack of extensive areas of erosion.* Nothing is seen at all comparable in extent to what an outside observer would notice in inspecting the earth under similar circumstances. It is probable that all or nearly all of the larger craters were originally furnished with central peaks, but in most cases these were destroyed when the floors were liquefied. Of the peaks which are left, doubtless all at one time, as in the case of our terrestrial volcanoes, gave out large quantities of steam and volcanic gases. On account of the rare lunar atmosphere, due to the small force of gravity, this moisture would have been immediately precipitated as rain or snow, so that the erosion would have been confined to, and concentrated about the vents.

In the lunar craters the only evidences of erosion are in fact found on these central peaks, but so marked is the effect in these places, that only a minority of the smooth cones of large size are left, while in the

majority of cases we find that they have been partially cut, and sometimes almost completely worn away. By arranging the cones according to the denundation exhibited we may form them into a continuous sequence, and thus study the process nearly as well as if we actually saw the destruction going on before our eyes. To aid us in this endeavor we have arranged them in five classes as follows:—

(*a*) Cones exhibiting little or no erosion. Perhaps the best examples of this class are found in Alpetragius and Godin.

(*b*) Cones in which the ravines occupy less than one-eighth the total volume of the cones, Agrippa, Pallas.

(*c*) Cones where the ratio of volumes is one-eighth to one-quarter, Tycho, Eratosthenes.

(*d*) Cones where the ratio is one-quarter to one-half, Theophilus Maurolycus.

(*e*) Cones where the ratio is over one-half, and which are therefore divided into several portions, Copernicus, Aristillus.

In the following table 45 of the chief cones are classified under these five heads:—

CLASSIFICATION OF CRATER CONES.

a	*b*	*c*	*d*	*e*
Alpetragius	Agrippa	Albategnius	Bullialdus	Aristillus
Alphonsus	Arzachel	Eratosthenes	Maurolycus	Aristoteles
Doppelmayer	Burg	Miller	Piccolomini	Atlas
Fabricius	Herschel	Landsberg	Theophilus	Antolycus
Godin	Manilius	Langrenus		Clavius
Hahn	Mayer, C.	Plinius		Copernicus
Kepler	Pallas	Tycho		Eudoxus
Lilius	Taruntius	Vitello		Gassendi
Pitatus	Vlacq			Maginus
Römer				Petavius
Timaeus				Stevinus
Ukert				Werner

In the cases of Alphonsus and Pitatus the floors have been so deeply flooded with lava during the period of the great fissure eruptions, that only the extreme summits of the cones are left above the surface. Their very small size leads us to believe, were the lower slopes visible in their entirety, that they might properly be placed in one of the later classes, instead of in class (*a*). Although class (*d*) covers an erosion of a quarter of the total volume of the cone, yet it contains very few specimens. This indicates that the destructive agencies worked more rapidly when this stage of the process was reached. When the cones are near the limb, it is impossible to determine in which class they should be placed. Several large and well-known craters have been

omitted from this classification on this account. In the case of Copernicus the original cone is now divided into three separate mountains. These mountains are but a vestige of the great central peak which formerly existed, and whose ruins lie scattered over the southern half of the floor.

The cross sections of the ravines cutting the sides of these cones are U-shaped, and not like a V. On the earth this would imply the action of ice rather than water. The same is doubtless true upon the moon, and this tells us that in those early days the lunar atmosphere was too rare to permit water to form in large quantities, for no river beds leave the bottoms of these ravines, the ice simply evaporated, after covering the floor of the crater. Unfortunately, as above mentioned, the original floors have in most cases been destroyed. This is shown by the smoothness and lack of detail exhibited, showing them like the maria, to have solidified from a liquid surface. When not actually melted, the floor has in many cases been softened, thereby destroying much of its original character. In those few floors that are left unchanged, or which have been only partly destroyed, we find the *debris* at the base of the cone is often radially disposed, the ridges on the floor accurately prolonging the sides of the ravines. So many instances of this occur that it cannot be due to accident, and no volcanic explanation seems available. These ridges are occasionally winding, as in Tycho, but usually they are fairly straight, as in Theophilus.

The only possible explanation for them seems to be that they are lateral moraines left by the great glaciers which have long since disappeared. They are shown in Copernicus and also in Arzachel, in both cases extending towards the south. In Pallas, Tycho, and Theophilus they extend towards the north. Such delicate detail is generally only shown by its shadow, so that it would be almost impossible to detect moraines lying in an east or west direction if such exist. Nevertheless, two lines of lighter color cross the dark floor of Bullialdus towards the west, from a ravine in the central cone. In this case when the floor was melted and mixed with darker colored lava from beneath, the lighter colored moraines seem not to have been entirely destroyed. A well marked moraine also crosses the floor south of the peak.

Although these great central cones have in most cases long since ceased to give out the vapor whose condensation worked their destruction, yet in a few cases some activity is still apparent, for we find the cone much the brightest portion of the crater, indicating that a little vapor is still emitted, and has fallen as snow upon it. Theophilus is a notable example of this fact. Piccolomini, Bullialdus, and Alphonsus

also show bright peaks. These snow areas slowly change their size and shape, generally disappearing as the lunation progresses. On Bullialdus the imprisoned vapors do not seem to be released until after the sun has been shining on the peak for several hours. General brightening then occurs.

Theophilus exhibits the most interesting changes, however. The snow which at first covers a considerable area in continuous masses, by colongitude 34° begins to break up into separate patches, which change their shape and size notably as the lunation progresses. They grow smaller and smaller as the sun rises higher, and finally at about colongitude 110° the spots suddenly disappear and are replaced by a large faint continuous surface of freshly formed frost or snow. This in turn gradually brightens until sunset. It is like the formation in autumn of the new polar cap on Mars. It should be noted that as in the case of Pico, Teneriffe, and other lunar mountains, the snow in Theophilus at present lies only on the ridges and never gets so far down as the ravines. In the cases of both Theophilus and Alphonsus the central peaks soon become hazy due to the formation of cloud about them. This is most readily seen in Alphonsus on account of the small size of its peak. It can best be detected by a comparison with the sharpness of definition of some of the small craters upon their floors, but the observation requires excellent atmospheric definition.

For the benefit of those persons not having access to a good telescope working under favorable atmospheric conditions, it may be mentioned that these ravines and even the lateral moraines are well shown on a lantern slide of Theophilus taken a number of years ago at the Yerkes Observatory, and which was at the time pretty widely distributed. Two ravines side by side are seen on the northern side of the central peak, and from the two sides of the right hand of these two lateral moraines or ridges, indicated by the darker shading of the floor, are seen extending nearly due north to the edge of the crater floor.

In addition to the volcanic cones the riverbeds of the moon form another clear indication of former erosive action. Between thirty and forty of these are now known to exist, Harvard Annals **32**, 87. The most characteristic of them, and the one which is best seen, lies in a valley of the Apennines east of Mt. Hadley. It is shown in Plate 7 of the Harvard Annals **32**, and somewhat imperfectly in "The Moon", p. 43, by the writer. Two excellent examples also lie to the west of Plato, and north of the valley of the Alps. Another one lies to the east of Plato, and a very short one in its southern slope. In the Annals a riverbed in the northern part of Petavius is figured and described as at that time, in 1892, the "next largest after that upon Mt. Hadley." It is now only seen with difficulty after full moon, and it would almost seem as if some change had taken place in the mean time in this formation.

June 9, 1916.

UPON THE PROJECT TO ADVANCE THE LEGAL HOUR.

(From the address by M. Camille Flammarion, in L'Astronomie, June, 1916.)

"This idea of preferring morning's pure and sunny atmosphere to the night's mists is not at all new. 'Hours of morning, hours of gain', said an old proverb, before the births of any of us. None of us is yet 132 years of age; but in 1784 Franklin, who resided at Passy from 1776 to 1785, stated in the *Journal de Paris* that he was making a discovery respecting the customs of Parisians; that the sun shone upon us as soon as it rose, and that Parisians are not reasoning people. 'My liking for economy', said he in this article, recently brought to light by Professor Richet, 'has led me to make the following calculation: the six months from March 20 to September 20 yield 183 nights. I multiply this number by 7 in order to obtain the hours during which we burn taper or candle, and I get 1,281 hours. Since there are 100,000 families, I obtain 128,100,000 hours of consumption, which represents an annual waste of 96,075,000 *Tours livres*, in wax or tallow, for the whole of Paris (more than a hundred millions of francs)'.

"Although speaking in praise of the lamps of 'Monsieur Quinquet', the writer declares that he much prefers the light of the Sun.

"And in order to interest the Parisians in thrift, the illustrious philosopher proposes:

First, *To lay a tax of one louis upon every window which has shutters preventing light from entering when the sun is on the horizon.*

Second, *To ring all the church bells at sunrise, and, if that is not sufficient, to shoot off cannon in every street.*

"The idea which should predominate among us is that the 'hour' is merely a convention, a *fiction*, ever since the law in 1816 which substituted mean time for solar time. In the epoch of Louis XIV, also, did not the clock-makers of Paris take for a coat-of-arms a clock with this proud motto: *Solis Mendaces Arguit Horas*? 'It proves that the hours of the sun are false.' Solar dial-plates do not regulate any more the hour of day. Noon is no longer, since 1816—just a century—the middle of the day. In the department of Alpes-Maritimes the difference can equal three quarters of a hour, and at Menton night in winter comes at half-past three, p. m.

"Modern customs, besides, have unwedged life of more than an hour. Since the time of Louis XIV we have dined later and later; it is the same in going to bed, and, consequently, in rising. The meanings of the words themselves have changed. A theatre 'matinée' takes place from three to five o'clock in the afternoon.

"The active existence of governments, of offices, occurs between 8 o'clock in the morning and 6 o'clock at night. In the cities the whole daily life of the inhabitants is based upon this practical activity, the centre of which is not the noon, but an *hour.*

"This project of advancing the legal hour is a simple measure of economy, well worthy of attention at this moment, and, at the same time, well deserving of general hygienics.

"The economic saving would be general. Consider simply the post-office department. The advance of an hour diminishes especially the use of artificial light. It would be the same in all families, in most of the industries. The present coal crisis would be checked by it.

"On the other hand, what pleasure would all the workmen not have who until now have not been able to leave their desks, shops and factories till night, and who are not able to enjoy in the spring time some delightful hours at sunset!

"Certainly, the project is debatable from the strictly cosmoramic point of view. Although a convention, a fiction, the civil hour should depart as little as possible from the solar hour. The regulation of 1816 had already put perceptibly into disagreement solar sun-dials and clocks. The substitution of the Greenwich meridian for that of Paris, in 1911, has added nine minutes to the difference. The proposed new hour will increase still more the difference, particularly for western France; but this difference diminishes from west to east, and the departments of Bouches-du-Rhone, Var, Alpes-Maritimes, Hautes et Basses-Alpes, Savoie and Haute-Savoie, as well as the Vosges, Alsace and Lorraine, will find it in nearly their solar hour.

"Let us not forget that the *only true hour is the local hour* the solar hour, and that *the rest is pure convention.*

"One more word, gentlemen, in closing this presentation of the problem. When the inhabitants of our planet have, by chance, a good idea, they are incapable of preserving it. The question which agitates and divides us at this moment would never have been raised if mankind had kept the international and logical meridian of the island of Fer, adopted in our ancient charts, which, situated at the most westerly point of the European world, in the Canaries, is 20½ degrees from Paris, so that France will belong naturally to the second spindle of the 24 hours. But natural rivalries have spoiled everything. They have committed and commit indeed other mistakes,—and some stupidities perceptibly more serious."

Translated by CHARLES NEVERS HOLMES.

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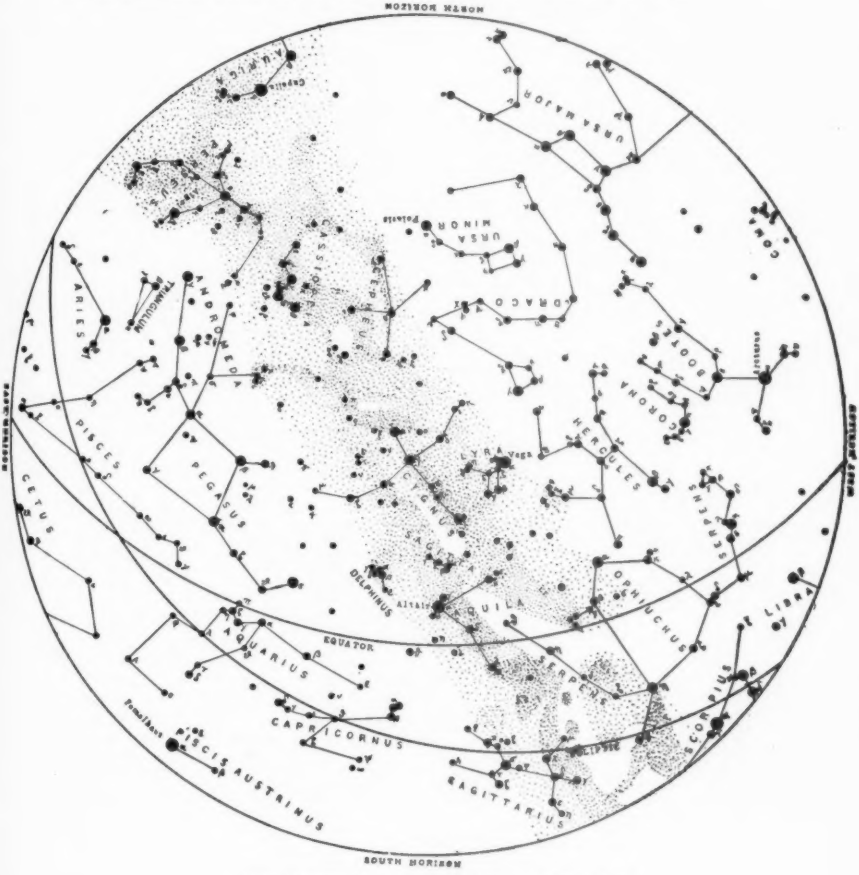
PLANET NOTES FOR SEPTEMBER AND OCTOBER, 1916.

During these two months the sun will follow a south-easterly course through the sky, crossing the equator on September 22, thereby marking the time of the autumnal equinox. It will begin this period in the constellation Leo, a little to the east of Regulus, pass through a region in which there are no conspicuous stars into the constellation Virgo, and end the period a little to the east of Spica.



THE CONSTELLATIONS AT 9:00 P. M. SEPTEMBER 1.

The phases of the moon for these months are as follows:

First Quarter	Sept. 4	at	10 P.M.	C.S.T.
Full Moon	11	"	3 P.M.	"
Last Quarter	18	"	12 P.M.	"
New Moon	27	"	2 A.M.	"
First Quarter	Oct. 4	"	5 A.M.	"
Full Moon	11	"	1 A.M.	"
Last Quarter	18	"	7 P.M.	"
New Moon	26	"	3 P.M.	"

Mercury will be visible twice during these two months. On September 9 it will reach a position of greatest elongation east of the sun. On and near this date therefore it will be visible in the evening sky. It will set a little south of the point of sunset at this date. It will be brighter than a first magnitude star and should be found easily. It will immediately move towards the sun and pass between the earth and the sun on October 4. It will then swing out to the west of the sun and become visible as a morning star a little after the middle of October. It will probably be visible during the remainder of the month.

Venus will be brilliant in the morning sky throughout this period. It will reach its point of greatest angular distance from the sun on September 12. It will then appear in the telescope as a half moon and will be very bright.

Mars will still be visible in the evening sky throughout this period. It will, however, not be in a favorable position for observation as it will be quite far south and will set soon after sunset. It will also be at a great distance from the earth and receding, consequently it will not be very bright.

Jupiter will be coming into favorable position during these two months. It will rise before midnight at the beginning of the period, and will rise earlier each succeeding night. By October 23 Jupiter will be in opposition with the sun, and will consequently be on the meridian at midnight. At this date it will have its maximum brightness, and will be very conspicuous in the eastern sky in the evening.

Saturn will rise before the sun during this period and may be seen in the morning sky at the beginning of September. By the end of October it will be rising about midnight.

Uranus will be well situated. It will cross the meridian about nine o'clock in the evening as an average during this period. It will be in the constellation Capricornus.

Neptune will not be far from Saturn during this period. It will be in the constellation Cancer.

Occultations Visible at Washington.

Date 1916		Star's Name	Magnitude	IMMERSION. Washington M.T.		Angle f'm N.	EMERSION. Washington M.T.		Angle f'm N.	Duration	
				h	m	°	h	m	°	h	m
Sept.	4	116 B Scorpii	6.2	5	1	54	6	0	323	1	0
	9	96 B Aquarii	6.5	15	9	356	15	35	302	0	26
	15	ϵ Arietis	4.6	8	16	40	9	2	298	0	46
	18	139 Tauri	4.7	16	45	19	17	13	344	0	28
	21	d^1 Cancri	5.9	12	54	146	13	33	236	0	39
Oct.	5	o Capricorni	5.6	10	12	5	10	50	296	0	39
	6	29 Capricorni	5.5	3	15	94	4	14	225	0	59
	7	ρ Aquarii	5.3	9	56	82	11	1	204	1	4
	7	170 B Aquarii	6.0	12	13	79	13	13	214	1	0
	12	μ Arietis	5.7	10	23	127	10	54	177	0	32
	13	66 Arietis	6.1	6	30	28	7	6	297	0	36
	13	17 Tauri	3.8	15	28	27	16	20	312	0	52
	13	23 Tauri	4.3	16	2	84	17	23	262	1	22
	13	η Tauri	3.0	16	52	56	17	59	294	1	7
	13	27 Tauri	3.7	17	45	76	18	54	278	1	9
	13	28 Tauri	5.2	17	50	56	18	51	297	1	1
	19	o^2 Cancri	5.7	14	17	85	15	25	314	1	8
	19	o^1 Cancri	5.1	14	26	152	15	19	246	0	54

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by Agnes E. Wells at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1916 Sept.-Oct.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	5 17			10 15				
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	3 17;	19 1;	12 2;	27 10				
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	6 0;	20 20;	13 4;	28 0				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	10 13;	25 12;	10 11;	25 10				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	13 2;	25 8;	7 13;	25 21				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	12 3;	26 9;	10 16;	24 23				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	6 4;	26 18;	10 11;	24 5				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	8 16;	23 1;	7 9;	21 17				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	8 22;	26 12;	5 6;	22 20				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	10 10;	26 8;	12 5;	28 2				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6		23 11		25 19				
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	10 4;	21 15;	8 18;	25 23				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	3 17;	17 7;	7 17;	21 7				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	4 13;	20 8;	6 4;	21 23				
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	6 15;	23 6;	1 14;	18 4				
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	9 4;	24 23;	2 20;	18 15				
RW Persei	13.3	+42 04	8.8—11.0	15 04.8	6 15;	19 19;	3 0;	29 10				
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	9 22;	28 19;	8 6;	27 3				
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	7 21;	20 7;	2 17;	27 14				
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	4 15;	17 23;	7 23;	27 23				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	10 5;	21 2;	7 11;	23 20				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	10 6;	22 7;	10 8;	28 10				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	3 6;	20 14;	7 22;	25 7				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	9 15;	30 10;	10 20;	31 16				
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	7 18;	23 19;	9 19;	25 20				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	12 11;	23 22;	11 3;	22 14				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	9 15;	20 19;	7 15;	24 10				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	12 22;	29 8;	7 13;	23 22				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	12 5;	27 11;	5 2;	27 23				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	12 18;	24 23;	7 4;	31 14				
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	7 0;	21 9;	12 21;	27 5				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	12 15;	30 19;	9 21;	28 1				
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	5 9;	24 0;	3 7;	21 21				
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	18 21;	28 19;	18 14;	28 13				
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	8 20;	25 15;	13 10;	30 5				
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	4 5;	23 12;	12 19;	25 15				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	8 11;	23 0;	14 20;	29 9				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	3 23;	20 4;	6 10;	22 16				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	10 10;	29 10;	8 21;	27 21				
RX Hydrae	9 00.8	− 7 52	9.1—10.5	2 6.8	3 22;	22 5;	10 11;	28 17				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	7 23;	19 19;	7 15;	25 10				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	7 23;	24 19;	11 16;	28 13				
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	6 1;	24 14;	3 20;	22 9				
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	4 21;	18 2;	7 22;	27 17				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	8 10;	26 0;	13 14;	31 5				
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	5 14;	20 6;	12 5;	26 21				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	10 1;	23 15;	13 23;	27 13				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	9 21;	24 21;	9 21;	24 21				
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.2	6 1;	25 6;	4 20;	24 1				
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	7 21;	22 18;	15 2;	29 22				
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	13 19;	27 18;	11 17;	25 16				

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1916 Sept.-Oct.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	11 13;	25 7;	9 2;	22 22				
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	13 20;	30 16;	9 2;	25 22				
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	9 18;	25 1;	10 9;	25 16				
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	6 12;	21 4;	5 20;	20 12				
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5	11 18;	28 6;	14 19;	31 7				
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	7 6;	24 23;	12 15;	30 8				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	14 3;	25 4;	4 21;	25 15				
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	7 10;	21 1;	11 11;	25 1				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	7 17;	24 11;	11 6;	28 0				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	5 6;	23 17;	6 0;	18 7				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	8 19;	23 5;	7 15;	22 1				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	3 12;	18 6;	10 9;	25 3				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	6 3;	22 11;	8 20;	25 5				
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	11 0;	26 2;	11 4;	26 6				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	10 2;	25 13;	11 1;	26 13				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	8 19;	24 18;	10 17;	26 17				
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	7 14;	24 15;	3 4;	20 5				
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	8 7;	27 0;	6 8;	25 0				
SX Draconis	18 03.0	+ 58 23	9.3—10.5	5 04.1	5 22;	26 14;	6 22;	27 14				
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	3 16;	18 4;	9 22;	24 9				
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	8 23;	22 19;	13 12;	27 8				
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2	15 8;	30 12;	15 15;	30 18				
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	13 2;	29 15;	7 21;	24 10				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	13 14;	22 11;	10 6;	28 1				
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	6 15;	23 5;	9 20;	26 11				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	13 10;	30 10;	8 21;	25 21				
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	10 18;	24 1;	7 8;	27 6				
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	8 2;	21 0;	3 22;	29 17				
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	8 2;	27 4;	6 18;	25 20				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	9 12;	24 15;	9 19;	24 22				
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	14 12;	28 21;	13 7;	27 16				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	9 17;	27 15;	6 14;	24 12				
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	8 3;	22 16;	6 5;	26 11				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	8 21;	23 14;	8 8;	23 1				
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	10 10;	20 22;	6 15;	22 9				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	8 8;	21 9;	10 22;	23 23				
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	7 15;	19 15;	7 15;	25 16				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	8 4;	28 2;	11 8;	24 15				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	9 23;	28 6;	16 13;	25 17				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	4 18;	21 15;	8 11;	25 8				
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	8 20;	29 4;	12 18;	26 8				
UW Cygni	19.6	+42 55	10.5—10.8	3 13	8 8;	22 3;	12 20;	26 15				
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0		28 4						
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	8 10;	27 15;	7 6;	26 11				
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	10 18;	29 4;	8 8;	26 17				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	4 10;	26 21;	11 21;	26 20				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	7 8;	19 1;	12 9;	24 2				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	8 14;	28 19;	8 21;	29 2				
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	3 22;	18 16;	3 11;	25 14				
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	5 12;	24 21;	4 14;	23 23				
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	2 12;	26 3;	11 20;	27 14				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3		21 1		22 8				
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	1 14;	21 21;	2 1;	22 8				
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	8 0;	23 14;	9 3;	24 16				
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	6 16;	23 0;	9 8;	20 5				
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	7 8;	23 22;	10 12;	27 2				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	8 19;	23 20;	8 22;	23 23				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	11 23;	28 11;	14 22;	31 10				

Maxima of Variable Stars of Short Period.

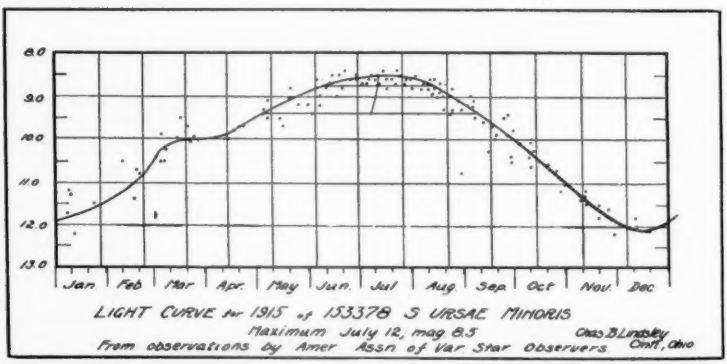
[Calculated by Bertha Booth and Bessie Burnham at Goodsell Observatory.]

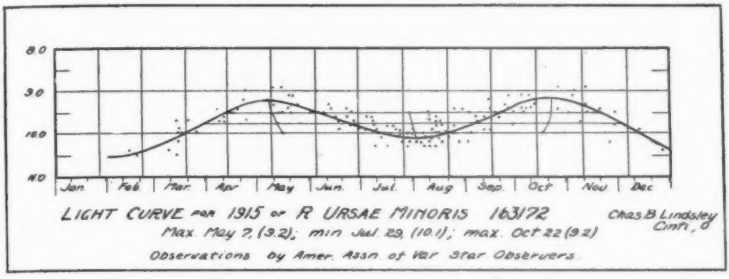
Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1916. Sept.-Oct.
	h m	° ′		d h	d h d h d h d h d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7	24 0 29 13
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	11 17; 27 23; 14 6; 30 13
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	9 0; 24 12; 9 23; 25 11
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	10 17; 25 12; 10 7; 25 2
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	8 13; 24 10; 10 7; 26 4
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	4 6; 19 20; 5 10; 21 0
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	13 19; 28 9; 12 23; 27 12
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	14 30 16
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	7 13; 24 17; 11 21; 29 1
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	6 18; 29 0; 10 3; 21 6
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	10 12; 22 3; 3 18; 27 0
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	8 18; 24 2; 9 9; 24 17
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	10 19; 20 22; 11 5; 31 11
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	9 13; 24 23; 10 10; 25 20
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	8 19; 25 9; 11 22; 23 0
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	12 16; 27 19; 12 22; 28 1
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	6 20 3 20; 30 20
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	10 20; 25 6; 9 16; 24 2
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	12 1; 27 21; 5 19; 21 15
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	12 8; 22 12; 2 16; 22 23
RU Camelop.	7 10.9	+69 51	8.5— 9.8	12 06.5	9 10; 1 16; 23 22
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	14 12; 30 18; 8 18; 24 15
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	5 15; 19 0; 9 2; 22 12
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	11 17; 30 7; 9 13; 28 2
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	7 16; 25 4; 12 15; 30 3
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 0.0	22
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	8 1; 21 14; 11 23; 25 13
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	10 1; 23 6; 6 11; 19 16
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	7 2; 26 10; 5 1; 24 9
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	10 15; 26 4; 12 3; 28 2
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	13 13; 27 10; 10 21; 24 8
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	7 9; 24 20; 12 7; 23 23
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	7 10; 21 11; 10 5; 24 7
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	12 6; 29 13; 16 19
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	11 0; 27 10; 13 19; 30 5
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	12 3; 26 4; 10 5; 31 6
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	8 13; 25 0; 11 10; 27 20
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	11 7; 22 7; 14 6; 25 6
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	11 8; 26 9; 11 11; 26 14
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	13 2; 27 22; 12 18; 27 14
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	8 16; 22 5; 5 18; 19 8
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	11 21; 24 13; 13 12; 26 3
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	8 0; 27 12; 7 6; 26 19
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	3 6; 20 23; 8 16; 26 9
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	11 13; 23 16; 11 21; 24 0
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	13 5; 27 6; 11 6; 25 7
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	17 21; 4 0; 21 3
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	7 11; 22 16; 15 10; 30 15
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	8 17; 20 6; 7 13; 24 21
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	13 0; 26 11; 9 24; 23 11

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1916. Sept.-Oct.							
	h m	° ′		d h	d	h	d	h	d	h	d	h
Y Scuti	18 32.6	− 8 27	8.7— 9.2	10 08.3	11	6;	21	15;	1	23;	22	16
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	9	23;	22	0;	10	3;	22	4
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	12	2;	24	9;	12	18;	25	1
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	12	6;	24	4;	12	0;	23	21
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	4	15;	22	20;	11	0;	29	4
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	13	14;	27	14;	11	14;	25	17
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	13	5;	27	4;	11	4;	25	4
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	11	23;	27	22;	5	21;	21	20
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	11	6;	24	15;	11	0;	26	8
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	6	17;	21	2;	5	10;	19	19
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	6	22;	23	16;	10	11;	27	5
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	9	11;	22	2;	11	1;	23	17
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	12	18;	29	3;	15	13;	31	22
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	12	18;	26	1;	9	8;	27	2
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	8	0;	21	10;	11	16;	25	2
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	13	15;	27	1;	10	11;	23	22
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	15	1;	29	18;	14	12;	29	5
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	10	23;	26	16;	12	9;	20	6
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	12	10;	26	15;	10	9;	24	4
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	6	5;	20	19;	10	6;	24	20
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	3	16;	21	0;	8	7;	25	13
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	12	21;	23	15;	9	17;	25	19
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	1	10;	23	4;	4	1;	25	19
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	10	0;	22	21;	5	17;	24	23
V Lacertae	22 44.5	+55 48	8.5— 9.5	4 23.6	9	7;	24	6;	9	5;	24	4
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	4	7;	20	14;	6	22;	23	6
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	9	23;	22	13;	11	11;	24	1
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	11	21;	24	1;	6	4;	30	11
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.6	9	3;	24	2;	9	1;	24	0

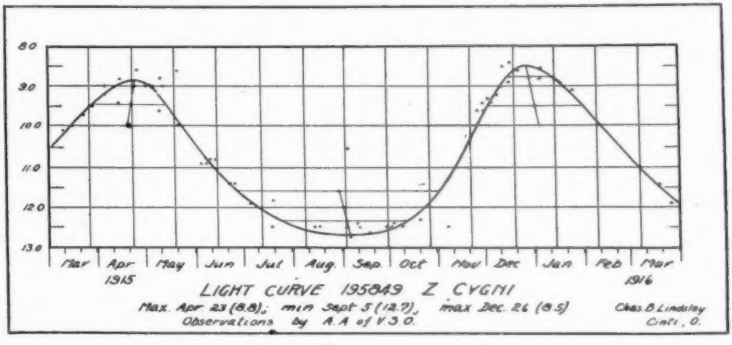




LIGHT CURVE FOR 1915 OF R URSAE MINORIS 163172 Chas.B.Lindsley Cinti., O

Max. May 7, (9.2); min Jul. 29, (10.1); max. Oct 22 (9.2)

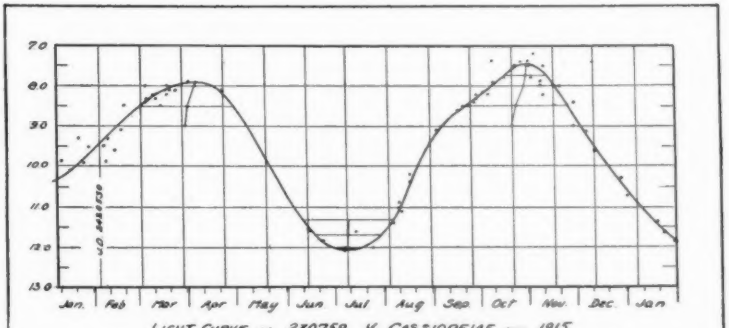
Observations by Amer. Assn of Var Star Observers.



LIGHT CURVE 195849 Z CYGNI

Max. Apr 23 (8.8); min Sept 5 (12.7), max Dec. 26 (8.5) Chas.B.Lindsley Cinti., O.

Observations by A.A of V.S.O.



LIGHT CURVE OF 230759 V CASSIOPEIAE FOR 1915

Max. I, Apr 5 (J.D. 2420533), mag 7.9. Max 2, Oct 28 (J.D. 2420799), mag 7.5

Min July 6 (J.D. 2420667), mag. 12.1 C.B. Lindsley Cinti., O

Observations by Amer. Assn. of Var Star Observers

COMET AND ASTEROID NOTES.

Comet 1916 *b* (Wolf).—The new comet which was announced in our last number is quite remarkable, in that it was discovered at almost the distance of Jupiter from the sun. It is in the opposite part of the sky from that now occupied by Jupiter, so that it is not subject to any sensible perturbations by that planet. The orbit is very uncertain yet, but it is probable that the elliptic orbit computed by Van Biesbroeck is not correct. The best elements which have come to hand are those given in the *Lick Observatory Bulletin* No. 282, computed by R. T. Crawford and Dinsmore Alter, which represent 13 observations from April 24 to May 30 with great accuracy. These elements are parabolic and indicate that the comet will reach perihelion about June 16, 1917. Professor E. E. Barnard found an image of the comet on a photograph taken April 24, three days before the discovery by Wolf.

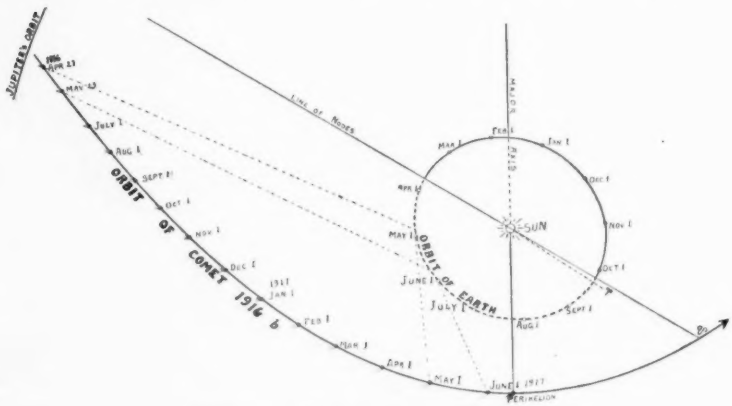
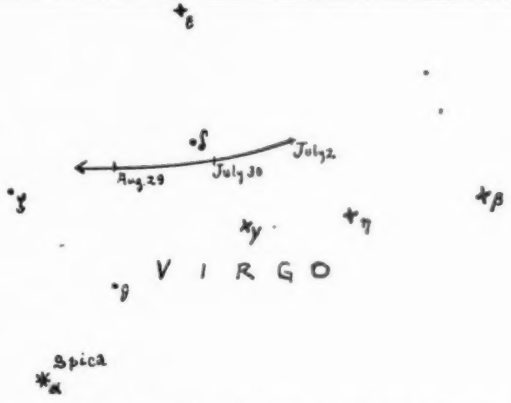


DIAGRAM OF THE ORBIT OF COMET 1916 *b* (WOLF).

The accompanying diagram shows the relation of part of the comet's orbit to the orbits of the earth and Jupiter. It is evident that next summer when the comet reaches perihelion it will be much more favorably situated for observation than it is now and that it may become a conspicuous object.

ELEMENTS BY CRAWFORD AND ALTER.

T = 1917 June 16.4806 Gr. M, T.
ω = 120° 37′ 07″.9
Ω = 183 16 58 .8 } 1916.0
i = 25 40 06 .4
log q = 0.226855 q = 1.683



APPARENT COURSE OF COMET 1916 *b* AMONG THE STARS IN JULY AND AUGUST.

The following ephemeris for the month of August is given in the *L. O. Bulletin* 282.

Gr. M. T. 1916	True α	True δ	log Δ	Brightness
	h m s	° ′ ″		
Aug. 1.5	12 46 21.0	+3 33 21		
3.5	47 40.3	26 54		
5.5	49 02.2	20 15	0.6562	1.16
7.5	50 26.5	13 23		
9.5	51 53.3	3 06 19		
11.5	53 22.5	2 59 04		
13.5	54 54.0	51 37	0.6584	1.19
15.5	56 27.9	44 00		
17.6	58 04.1	36 12		
19.5	12 59 42.6	28 14		
21.5	13 01 23.3	20 07	0.6598	1.23
23.5	03 06.2	11 50		
25.5	04 51.4	2 03 24		
27.5	06 38.8	1 54 50		
29.5	13 08 28.4	+1 46 08	0.6602	1.27

The elements bear a slight resemblance to those of Wolf's periodic comet 1884 III, but Professor Crawford thinks that the two cannot be identical.

Comet 1889 V Brooks.—On July 6, 1889 a comet was discovered by Dr. Wm. R. Brooks of Geneva, New York. When first seen it was rather faint, but had a short tail. It did not seem to change much in appearance until the following month, when it threw off four fragments. Two of these soon disappeared but the other two followed the main comet for a while and then gradually drifted away from it. In three weeks the nearer companion ceased to recede. Elements of the orbit were computed and its period was found to be a little over seven years. The small inclination and direct motion, and its periodic time suggested that it might possibly belong to Jupiter's family of comets. This fact was soon established by the investigations of Chandler and Poor in this country, and Bauschinger in Germany. It was found that the orbit at aphelion approaches very close to that of Jupiter, and Dr. Chandler found that in March 1886 the comet's distance from

the planet was slightly less than nine millions of miles. The comet returned in 1896 according to calculations, and was first seen by Javelle at Nice as a single comet, no companion being seen. It was observed for many weeks. In 1903 it returned again, and was first seen by Dr. Aitken at the Lick Observatory. The diameter of the nucleus was about 3′, and it was slightly fainter than 14th magnitude. The comet seems to be gradually diminishing in brightness. It returned in 1910, and the next perihelion passage is due to take place February 15, 1918. The comet will probably not return in 1925, as it will make another near approach to Jupiter during March 13-20, 1922. The nearest approach will take place on March 16 of that year, when the least distance between the two bodies will be only 0.136 of an astronomical unit. I have computed a search ephemeris for August 20 to September 5 and September 25 to October 11 this year. I have also computed the heliocentric coördinates of both Jupiter and the comet for March 16, 1922 the next date of nearest approach.

SEARCH EPHEMERIS FOR BROOKS' COMET 1889 V.

1916		α			δ			log r	log Δ
		h	m	s	°	′	″		
Aug.	20	14	25	30	−17	58	51	0.60740	0.62735
"	24	14	28	4	−18	10	26	0.60578	0.63137
"	28	14	30	49	−18	22	48	0.60414	0.63582
Sept.	1	14	33	45	−18	35	54	0.60250	0.63978
"	5	14	36	50	−18	49	41	0.60082	0.64352

Bright moon during interval September 5 to September 25.

		α			δ			log r	log Δ
		h	m	s	°	′	″		
Sept.	25	14	54	36	−20	6	38	0.59228	0.65898
"	29	14	58	34	−20	23	14	0.59054	0.66139
Oct.	3	15	2	40	−20	40	11	0.58876	0.66353
"	7	15	6	54	−20	57	19	0.58696	0.66542
"	11	15	11	13	−21	14	30	0.58518	0.66706

Heliocentric coördinates of Jupiter and Brooks' comet 1889 V at time of nearest approach, March 16, 1922.

Jupiter		°	′	″
λ	=	192	28	35
β	= +	1	18	27
log r	=	0.73692		

Comet		°	′	″
λ	=	192	58	12
β	= +	0	34	26
log r	=	0.72760		

$x' = -5.32630$
$y' = -1.17852$
$z' = +0.12451$

$x^\circ = -5.20410$
$y^\circ = -1.19861$
$z^\circ = +0.05349$

F. E. SEAGRAVE.

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, May, June, July, 1916.

In spite of an inclement and unseasonable spring, by reason of our scattered observing stations we are able to submit a favorable report, and maintain a good average. Our success is largely due to the efforts of Mr. Bancroft who contributes to the report 634 observations, the result of two months work. Mr. Bancroft is deserving of great credit for this example of zeal and industry.

It is a pleasure to welcome to our ranks this month Mr. Henry R. Schulmaier, "Sc" of Berwick, Me. Mr. Schulmaier observes with a 5″ refractor. His name was proposed by the Rev. T. C. H. Bouton. Other new members are Mr. A. W. Gregory "Gr" of Morristown, N. Y., and Mr. S. W. Pickering, "Wpi", the son of Mr. David B Pickering, who contributes his first list this month, twenty-three good observations. Miss Fanny M. Ludeke, "Lu" of Shandon, Cal., although only possessed of a field glass for observing, is worthy of membership in the Association by reason of her contributions of observations of the brighter variables. Mr. H. L. Baldwin returns to the active list this month. Mr. Baldwin is now located in Denver. Colo.

The following list of calculated dates of maxima is cited from the "Companion to the Observatory."

July	3	042209	R Tauri	Aug.	6	*191019*	R Sagittarii
	5	*022813*	U Ceti		7	050953	R Aurigae
	10	143227	R Boötis		12	*162112*	V Ophiuchi
	14	094211	R Leonis		16	193449	R Cygni
	16	123307	R Virginis		18	181136	W Lyrae
	19	001838	R Andromedae		20	081112	R Cancri
	21	*022000*	R Ceti		26	054920	U Orionis
	26	230759	V Cassiopeiae		26	043274	X Camelop.
					29	205923	R Vulpeculae

Space forbids extended comment on the many interesting features of this report. The recent maxima of the variable 213843 SS Cygni were well observed by a large number of our observers, and the irregular variable 154428 R Cor. Bor., is under such close scrutiny that any variation of moment is sure to be well observed. 147 observations of this variable in 65 days are recorded. The rapid increase in brilliance of the variable 090425 W Cancri seems especially noteworthy. This star has a period of 385 days, and recently in 44 days increased in brightness 4.0 magnitudes, an increase of 39.8 times, truly a remarkable performance for a variable with a period of this length.

The thanks of the Association are due Messrs. Bancroft, Eaton, McAteer, and others who contribute valuable early morning observations. Mr. McAteer observed a number of the neglected variables in Scorpius.

A highly gratifying feature of our work is the increase in the number of variables observed. A year ago we were observing about 140 variables, now we are approaching 200 variables a month, and contributing valuable observations of many variables heretofore neglected.

Those who have the Hagen tracing of the variable 203226 V Vulpeculae please correct the orientation. The south point is uppermost. Every member should carefully check up his observations each month with the report; where observations

VARIABLE STAR OBSERVATIONS May, June, July, 1916.

001046
X Androm.

J.D. 242	Est	Obs.
1037.7	11.6	Ba
42.8	<11.4	V

001755
T Cassiop.

0997.7	8.2	Pi
97.9	8.5	M
1015.7	8.4	S
18.9	8.7	M
41.7	8.5	Sp
43.7	8.1	Ba

001726
T Androm.

1034.9	9.8	E
37.7	9.8	Ba
42.8	9.2	V

001838
R Androm.

1010.8	8.0	Pi
32.9	7.8	M
34.9	7.5	E
37.7	7.6	Ba
42.8	7.1	V

004047
U Cassiop.

1037.7	11.6	Ba
37.8	9.7	M
38.9	11.3	E

004132
RW Androm.

1035.9	<11.5	E
37.7	<12.0	Ba

004435
V Androm.

1034.9	<11.1	E
37.7	<12.2	Ba
39.9	11.3	E

004533
RR Androm.

1037.7	11.8	Ba
39.9	<11.2	E
41.8	11.6	E

004746
RV Cassiop.

0997.9	<11.5	M
1037.8	10.1	M

004958
W Cassiop.

0982	9.5	L
97.9	9.6	M
1010.7	9.2	Ba
35.7	8.9	Ba
37.8	9.2	M

010940
U Androm.

J.D. 242	Est.	Obs.
1037.7	<12.0	Ba

013338
Y Androm.

1037.7	10.4	Ba

014958
X Cassiop.

0997.7	11.3	Pi
1032.9	10.5	M
43.7	11.0	Ba

015254
U Persei

1043.7	11.0	Ba

021558
S Persei

1043.7	8.8	Ba

023133
R Triang.

1035.9	10.3	E

024356
W Persei

0982	10.2	L
1043.7	8.9	Ba

025867
RX Cassiop.

0957	9.0	L

033362
U Camelop.

1005.6	7.5	Ba
45.7	7.8	Ba

043065
T Camelop.

1002.6	8.5	M
05.6	8.3	Ba
20.7	8.7	M

043274
X Camelop.

0957	8.7	L
80.7	10.5	R
86	10.6	L
87.6	10.9	V
93.6	11.3	Cr
93.6	11.1	Ba
96.6	11.4	Cr
1002.6	11.3	M
03.6	12.0	Ba
03.6	11.8	Cr
07.6	<11.1	V
08.6	11.5	M
10.6	11.9	Cr
10.6	12.2	Ba
11.6	11.6	M
18.6	<11.7	V
36.7	11.9	Pi

045514
R Leporis

J.D. 242	Est.	Obs.
0956	9.8	L
57	9.8	L

050953
R Aurigae

0993.6	9.0	M
97.5	8.6	Ba

052034
S Aurigae

0956	9.5	L
85.6	8.5	M

054920
U Orionis

0981.7	9.2	R
96	7.0	L

054974
V Camelop.

0993.6	<12.5	Ba
97.5	<12.5	Ba
1003.6	<13.3	Ba
05.6	13.1	Ba
07.6	<11.9	V
10.6	13.0	Ba
15.6	13.1	Ba
18.6	<11.3	V
27.6	<12.5	Ba

055353
Z Aurigae

0993.6	10.3	M
93.6	10.5	Ba

060450
X Aurigae

0956	11.2	L
81.7	9.2	R
92	8.9	L
93.6	8.3	N
93.6	8.5	Ba
95.6	8.4	Ba
1003.6	8.3	Ba
08.6	8.5	V
10.6	8.1	Ba

060547
SS Aurigae

0981.7	<10.8	R
87.6	<10.8	V
89.6	<12.8	B
90.6	<12.7	B
93.6	<12.4	Ba
93.6	<10.8	M
95.6	<12.0	Ba
96.6	<12.4	B
1003.6	<12.5	Ba
03.6	<13.3	B
05.6	11.7	Ba
08.6	<10.8	V
10.6	12.8	Ba

061647
V Aurigae

J.D. 242	Est.	Obs.
0993.6	<11.4	M

063159
U Lyncis

1005	<13.6	Ba

064030
X Gemin.

0989.6	11.4	V
93.6	10.8	Ba
97.6	10.7	Ba

065208
X Monoc.

0960	8.0	L
72	7.5	L
80	7.5	L
86	7.4	L

065355
R Lyncis

1005.6	9.6	Ba

070122
TW Gemin.

1009.7	8.3	R

070122
R Gemin.

0990.6	<12.5	B

070310
R Can. Min.

0950	10.0	L
80	9.0	L
81.7	9.1	R
92	9.0	L
96.6	8.6	B

071713
V Gemin.

0989.6	9.7	V
1010.6	8.4	Pi

072708
S Can. Min.

0956	10.8	L
80	11.5	L
81.6	<10.1	R

073508
U Can. Min.

0956	9.6	L
80	9.7	L
81.7	10.2	R
85.6	9.7	Bu
92	10.2	L
96.6	10.1	B

073723
S Gemin.

J.D. 242	Est.	Obs.
0988.6	10.6	Cr
1003.6	9.8	Cr
05.6	9.4	Cr
10.6	9.9	Cr
10.6	9.6	Pi

074922
U Gemin.

0985.6	<10.0	O
85.6	<11.4	M
88.6	<12.4	Cr
89.6	<11.7	V
90.6	<12.7	B
93.6	<12.5	Ba
93.6	<10.9	O
97.6	<12.5	Ba
1002.6	<10.9	M
02.6	<10.0	O
03.6	<13.5	B
03.6	<13.0	Ba
04.6	<12.3	Ba
05.6	<12.4	Cr
05.6	<12.5	Ba
08.6	<11.4	M
10.6	<12.8	B
10.6	<11.7	Pi
10.6	<12.7	Ba

081112
R Cancri

0956	8.6	L
85.6	8.3	Bu
96	7.3	L
97.6	7.3	Ba
1003.6	7.4	Ba

081617
V Cancri

0985.6	10.2	Bu
93.6	10.9	Ba
1005.6	11.0	Ba

082405
RT Hydrae

0974	8.1	L
85.6	7.8	Bu

083019
U Cancri

1015.6	<12.6	B

083350
X Urs. Maj.

1010.6	10.5	Ba

085120
T Cancri

0956	10.2	L
85.6	9.6	Bu
1002	10.5	L
05.6	9.8	Ba

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued.

090151
V Urs. Maj.

J.D. 242	Est.	Obs.
0954	10.3	L
72.3	10.0	L
74.3	10.3	L
80.3	10.3	L
80.7	10.1	R
81.7	10.2	R
82.3	10.2	L
82.6	10.2	L
85.6	9.8	M
85.7	9.5	Mu
89.6	10.3	V
91.7	9.6	Mu
93.6	10.2	Ba
96.3	10.4	L
1002.4	10.5	L
03.6	10.3	Ba
04.7	9.7	Mu
06.7	10.1	R
07.6	10.6	V
08.7	9.9	Mu
09.7	10.4	R
10.6	10.4	Ba
10.6	10.4	B
10.7	10.5	R
11.7	10.6	M
11.7	10.2	Mu
11.7	10.3	G
13.7	10.6	R
14.7	10.3	R
16.6	10.4	Ba
18.6	10.9	V
18.7	10.6	R
19.7	10.7	R
20.7	10.9	R
21.7	10.2	Mu
27.6	10.5	Ba
31.7	10.3	Mu
32.7	10.6	Mu
32.7	11.0	Pi
33.7	10.8	R
35.7	10.5	Mu
40.7	10.5	R
41.7	10.5	R
43.6	10.4	Ba

090425
W Cancri

J.D. 242	Est.	Obs.
0993.6	11.6	Ba
1003.6	11.1	Ba
07.7	10.2	V
10.6	10.0	Ba
15.6	8.9	B
16.6	9.0	Ba
16.6	8.9	S
18.7	8.5	M
33.6	7.5	Ba
37.6	7.5	Ba

093014
X Hydrae

J.D. 242	Est.	Obs.
0985.6	10.0	Bu

093934
R Leo. Min.

J.D. 242	Est.	Obs.
0985.6	9.2	Bu
85.7	10.0	M
92.7	9.2	R
93.6	9.3	Ba
1002.6	9.6	Hu
05.6	9.4	Ba
09.6	9.6	S
10.6	10.0	Pi
18.6	10.2	M
18.7	10.5	R
32.7	10.6	R
33.6	10.1	Ba
35.6 <	10.0	S
36.6 <	10.8	Wpi
36.6	10.8	Pi

094211
R Leonis

J.D. 242	Est.	Obs.
0972	9.6	L
85.6	9.6	Bu
85.7	9.4	Mu
85.7	9.7	M
90.6	9.0	Sc
90.6	8.8	B
91.7	9.5	Mu
92.7	9.3	E
92.7	10.4	R
93.6	9.1	Ba
93.6	8.8	B
1002	9.5	L
04.7	9.5	Mu
05. 6	9.0	Ba
08	8.9	Wh
09.6	9.2	S
08.7	9.6	Mu
10.6	9.2	Pi
11.7	9.0	Bl
11.7	9.5	Mu
11.7	9.4	G
14.7	9.8	R
16	8.9	T
18.6	8.9	M
19	8.8	T
27.6	9.0	Ba
32.7	9.8	R
33	8.9	Wh
36.6	8.8	Wpi
36.6	8.8	Pi
37.6	8.2	Ba
37.6	9.0	S

094622
Y Hydrae

J.D. 242	Est.	Obs.
0985.6	6.8	Bu

095421
V Leonis

J.D. 242	Est.	Obs.
0985.7 <	11.3	M
1018.7 <	11.5	M
37.6 <	12.6	B a

103212
U Hydrae

J.D. 242	Est.	Obs.
0974	5.0	L
0978.7	5.7	G
1009.7	5.3	R

103769
R Urs. Maj.

J.D. 242	Est.	Obs.
0993.6	12.1	Ba
97.6	12.2	Ba
1003.6	12.3	Ba
10.6	12.6	Ba
10.7 <	12.0	Pi
14.7	12.4	M
16.6	12.5	Ba
28.7 <	11.0	M
32.6	12.8	Ba
37.6	12.5	Ba
41.6	11.7	M
44.6	12.5	Ba

104620
V Hydrae

J.D. 242	Est.	Obs.
0974	6.2	L
85.6	6.3	Bu
1009.7	7.5	R

104814
W Leonis

J.D. 242	Est.	Obs.
1019.6 <	11.2	V
37.6 <	12.9	Ba

110506
S Leonis

J.D. 242	Est.	Obs.
1015.7	9.5	M

115919
R Comae

J.D. 242	Est.	Obs.
1002.6	10.8	O
03.6	10.5	Ba
03.6	10.8	B
09.6	10.2	O
10.6	10.0	Pi
10.6	10.2	Ba
11.6	10.5	M
15.6	9.8	O
15.7	9.5	Pi
16.6	9.6	Ba
17.6	9.5	O
18.7	9.2	M
20.7	9.5	R
27.6	9.0	Ba
28.7	9.1	M
35.6	8.8	B
36.6	8.8	Pi
36.6	9.3	Wpi
37.6	8.6	Ba

R Comae

J.D. 242	Est.	Obs.
1037.6	8.8	O
37.6	8.8	B
38.6	8.8	B
41.6	8.9	B
43.6	8.4	Ba
44.6	8.7	B
45.6	8.7	O

120012
SU Virginis

J.D. 242	Est.	Obs.
0985.6	9.2	Bu
89.7	9.5	V
91.6	9.6	Ba
93.6	9.3	B
1003.6	10.6	Ba
03.7	10.0	M
07.7	10.7	V
10.6	10.8	Ba
16.6	11.3	Ba
18.6	11.5	V
28.7	11.4	M
33.6	12.4	Ba
35.6	12.2	B
41.6	12.4	Ba

120905
T Virginis

J.D. 242	Est.	Obs.
0989.7	10.9	V
93.6	10.6	B
1003.7 <	10.6	M
05.6	11.6	Ba
16.6	11.9	Ba
35.6	12.8	B

121418
R Corvi

J.D. 242	Est.	Obs.
0985.6	7.6	Bu
88.6	7.9	Ma
91.6	7.9	Ba
93.6	7.8	B
93.6	8.2	M
1003.6	8.1	Ba
05.6	8.5	O
09.7	8.7	R
10.6	8.5	Pi
10.6	8.6	Ba
15.6	8.5	O
15.6	8.8	Ba
15	9.1	Nt
18.7	9.0	M
19.6	9.0	O
32.7	10.1	R
44.6	10.0	B

122001
SS Virginis

J.D. 242	Est.	Obs.
0985.6	8.3	Bu
91.6	8.1	Ba

SS Virginis

J.D. 242	Est.	Obs.
1003.6	8.2	Ba
03.6	8.0	B
03.7	9.5	M
04.6	8.5	Hu
10.6	8.3	Ba
16.6	8.3	Ba
20.7	9.1	M
27.6	8.2	Ba
37.6	8.2	Ba
44	9.2	Nt
45.6	8.1	Ba

122532
T Can. Ven.

J.D. 242	Est.	Obs.
0985.6	9.7	Bu
85.6	9.8	M
91.6	9.5	Ba
1003.6	9.4	Ba
10.6	9.4	Ba
16	8.9	T
16.6	9.5	Ba
20.7	9.5	M
27.6	9.5	Ba
35.6	9.6	Ba
35	9.0	T
36.6	10.3	WPi
36.6	9.9	Pi
43.6	9.7	Ba

122803
Y Virginis

J.D. 242	Est.	Obs.
1016.6 <	13.0	Ba
20.7 <	11.1	M
37.6	13.1	B
37.6	12.5	Ba

123160
T Urs. Maj.

J.D. 242	Est.	Obs.
0985.6	8.4	Bu
85.6	8.6	O
85.6	8.4	M
85.7	8.4	Mu
88.6	8.1	Ma
91.6	7.9	Ba
91.7	7.9	Mu
91.8	8.0	M
92.7	8.2	E
92.7	8.1	R
93.6	8.1	O
97.6	7.7	Ba
1003.6	7.7	Ba
03.7	8.2	M
07.6	7.8	Ma
09.7	8.2	S
10.6	7.7	Ba
10.7	7.6	Sp
10.7	7.6	R
10.7	8.1	Pi
12.7	8.1	M
15.6	7.3	Hu

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued.

123307
R Virginis

J.D. 242	Est.	Obs.
0974	10.1	L
85.6	9.0	O
85.6	9.2	Bu
90.7	8.1	Ba
90.7	8.6	O
92.7	8.4	E
92.7	8.1	R
93.6	8.2	O
93.6	8.0	B
1002.6	7.9	Pi
02.6	8.1	Wpi
03.6	7.9	Ba
03.7	7.8	M
04.6	7.9	Hu
09.6	7.8	O
09.6	7.9	S
09.6	7.6	Ma
10.6	7.7	Ba
10.7	7.3	R
15.6	7.1	O
16.6	7.2	Ma
16.6	7.7	Ba
20.7	7.6	M
27.6	7.6	Ba
32.7	7.0	R
35.6	7.5	Ba
43.6	7.5	Ma
43.6	7.5	Ba

123459
RS Urs. Maj.

J.D. 242	Est.	Obs.
0985.6 <	11.8	M
1003.6 <	13.0	Ba
12.7 <	11.3	M
14.7	13.5	M
16.6 <	13.0	Ba
20.7 <	11.8	M
27.6 <	12.4	Ba
32.6	13.4	Ba
37.6	13.4	Ba
41.6	13.3	Ba
42.6 <	10.6	Wpi
42.6 <	10.6	Pi

123961
S Urs. Maj.

J.D. 242	Est.	Obs.
0985.6	11.3	M
85.7	10.2	Mu
91.6	11.5	Ba
91.7	10.3	Mu
97.6	11.8	Ba
03.6	11.9	Ba
10.6	11.7	Ba
10.7	12.0	Sp
14.7	12.3	M
15.6	10.1	Hu
16.6	11.4	Ba
20.7	11.2	M
27.6	10.5	Ba
28.7	10.3	M
31.6	9.9	M
32.6	10.1	Ba
35.6	10.4	S
37.6	9.8	Ba
37.6	10.0	O
37.6	9.6	Hu
41	10.0	Nt
41.6	9.0	M
41.6	9.3	B
41.6	9.1	Ba
42.6	9.5	Pi
42.6	9.5	Ma
43.6	9.4	O
44.7	9.0	Sp
46.6	9.2	O
51.6	9.0	O

124204
RU Virginis

J.D. 242	Est.	Obs.
1016.6	13.0	Ba
32.6	13.5	Ba
32.7	10.9	R
37.6	13.3	Ba

124606
U Virginis

J.D. 242	Est.	Obs.
0986.6	8.5	Bu
91.6	8.5	Ba
92.7	8.7	E
93.6	8.7	O
1003.6	8.9	B

U Virginis

J.D. 242	Est.	Obs.
03.6	8.9	Ba
03.7	9.1	M
09.6	9.1	O
09.7	9.3	S
10.6	9.2	Ba
15.6	9.2	Hu
16.6	9.4	Ba
17.6	9.4	O
20.7	9.6	M
33.6	10.5	Ba
41.6	11.8	B
43.6	11.4	Ba

132002
W Virginis

J.D. 242	Est.	Obs.
1015.8	9.5	M
20.7	9.4	M

132202
V Virginis

J.D. 242	Est.	Obs.
0991.6	8.9	Ba
93.6	8.9	B
1003.6	9.1	Ba
12.7	9.5	M
15.8	9.8	M
16.6	9.5	Ba
20.7	9.6	M
37.6	10.2	Ba
41.6	10.8	B

132422
R Hydrae

J.D. 242	Est.	Obs.
0974	6.9	L
82	6.4	L
1004.7	6.2	Mu
07.6	5.5	Ma
10.7	5.1	R
16.6	5.6	Ma
33.7	5.5	R

132706
S Virginis

J.D. 242	Est.	Obs.
0974	11.0	L
91.6	11.4	Ba
1003.6	11.9	Ba
04.7	11.6	M
10.7 <	11.6	Pi
16.6	12.1	Ba
37.6	12.5	Ba
41.7 <	10.0	M
44 <	12.0	Nt

133273
T Urs. Min.

J.D. 242	Est.	Obs.
1010.6	12.1	Ba
16.6	12.0	Ba
19	10.0	T
27.6	11.7	Ba
33.6	11.3	Ba
36.6	10.9	V
43.6	10.3	Ba

133658
V Urs. Min.

J.D. 242	Est.	Obs.
01.9	8.2	T
33	8.4	T
37	8.2	T

134440
R Can. Ven.

J.D. 242	Est.	Obs.
0985.6	10.4	M
86.6	9.8	Bu
91.6	10.3	Ba
92.7	10.7	R
1003.6	10.4	Ba
10.7	10.7	Ba
15.6	11.0	Hu
15.7	12.0	S
16.6	10.8	Ba
16.7	10.5	Sp
19.7 <	10.5	R
20.7	10.8	M
27.6	11.0	Ba
35.6	11.4	Ba
36.6	11.2	Wpi
36.6	11.2	Pi
37.6	12.0	S
41.6	11.6	B
45.6	11.2	Ba

135908
RR Virginis

J.D. 242	Est.	Obs.
1005.6	12.9	Ba
41.6	12.0	M

140113
Z Bootis

J.D. 242	Est.	Obs.
1016.6 <	13.5	Ba
37.6 <	13.6	Ba

141567
U Urs. Min.

J.D. 242	Est.	Obs.
0986.6 <	10.7	Bu
91.6	10.8	Ba
1003.6	11.2	Ba
10.7	11.2	Ba
10.7	11.6	Pi
16.6	11.2	Ba
16.6	11.4	Pi
17.6	11.9	B
27.6	11.5	Ba
35.6	12.0	Ba
41.6	12.0	B
43.6	12.0	Ba

141954
S Bootis

J.D. 242	Est.	Obs.
0986.6	10.6	Bu
91.6	10.4	Ba
1002.6	10.5	Wpi
02.6	10.4	Pi
03.7	10.5	Ba
03.8	10.7	M
10.7	10.2	Ba
11.7	10.5	Bl

S Bootis

J.D. 242	Est.	Obs.
15.7	9.9	S
16.6	10.0	Ba
18.7	10.2	R
21.6	9.5	Sc
27.6	9.3	Ba
32.6	8.5	Wpi
32.6	8.7	Pi
32.8	8.7	M
33.7	8.3	R
35.6	8.7	Ba
43.6	8.5	Ba

141942
RX Bootis

J.D. 242	Est.	Obs.
01.6	7.8	T

142205
RS Virginis

J.D. 242	Est.	Obs.
0993.6	9.5	Ba
1003.6	8.2	Ba
10.6	8.2	B
10.7	8.2	Pi
15.8	8.3	M
16.6	7.9	Ba
33.6	7.9	Ba
43.6	8.4	Ba

142539
V Bootis

J.D. 242	Est.	Obs.
0954	9.7	L
84.7	10.6	Mu
86.6	9.6	Bu
86	9.2	L
91.7	8.9	Ba
91.7	9.4	Mu
93.6	9.3	O
95.5	9.0	Pi
96.6	8.8	B
1001.6	8.7	M
02.6	8.8	Wpi
02.6	9.2	O
02.6	8.8	Pi
03.6	8.8	Ba
04.7	9.2	Mu
07.6	8.5	Ma
09.6	8.5	Hu
10.7	9.0	R
11.7	8.5	Bl
11.7	8.6	G
15.6	8.3	Ba
15.7	8.8	S
19.6	8.2	Ba
27.6	8.0	Ba
32.6	8.0	Pi
32.6	8.1	Wpi
32.8	7.8	M
35.6	7.8	Ba
42.6	7.8	Pi
42.6	8.0	Wpi
42.7	7.5	Ma
43.6	7.7	Ba

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued.

142584
R Camelop.

J.D. 242	Est.	Obs.
0957	9.0	L
91.7	8.3	Ba
93.6	8.1	O
95.6	8.1	O
1002	8.2	Wh
02.6	8.1	O
03.6	8.0	Ba
05.6	8.2	Cr
09.6	8.1	O
10.7	8.2	B
10.7	8.2	Sp
10.7	8.4	R
13.6	8.1	O
15.6	8.0	Ba
15.6	8.0	Hu
15.7	8.2	Sp
17.6	8.1	O
19	8.0	T
19.6	8.2	Ba
27.6	8.1	Ba
33	8.4	Wh
37.6	8.4	Ba
37.6	8.2	O
37.6	8.0	Hu
37.7	8.9	M
37	8.2	T
41.7	8.3	Sp
43.6	8.4	O
45.6	8.5	Ba

143227
R Bootis

J.D. 242	Est.	Obs.
0974	10.9	L
86.6	9.9	Bu
91.7	9.5	Ba
93	9.2	O
95.6	9.3	O
96	9.0	L
1001.6	8.8	M
02.6	8.8	Wpi
02.6	9.1	O
02.6	9.0	Pi
03.6	8.9	Ba
1009.6	8.2	O
09.6	8.3	S
11.7	8.5	Bl
15.6	8.1	Ba
17.6	7.8	O
19.6	7.8	Ba
19.7	8.4	R
21.6	7.0	Sc
27.6	7.2	Ba
32.6	7.8	Wpi
32.6	7.4	Pi
32.8	7.6	M
35.6	7.0	Ba
37.6	7.1	O
43.6	6.9	Ba
44.7	7.4	Ma

144918
U Bootis

J.D. 242	Est.	Obs.
0986.6	<10.5	Bu
89.7	10.8	V
91.7	11.2	Ba
1003.6	11.5	Ba
08.6	11.4	B
12.8	11.5	M
15.6	11.3	Ba
19.6	11.5	Ba
35.6	11.5	Ba
35.6	11.5	B
45.6	11.4	Ba

150018
RT Librae

J.D. 242	Est.	Obs.
0993.6	<13.0	Ba
1033.6	13.5	Ba
42.6	11.4	M

150519
T Librae

J.D. 242	Est.	Obs.
0993.6	<12.5	Ba
1033.6	13.3	Ba
42.6	11.2	M

150605
Y Librae

J.D. 242	Est.	Obs.
0968	12.0	L
0993.6	12.9	Ba
1015.7	12.0	Pi
35.6	<13.0	Ba
41.6	11.4	M

151520
S Librae

J.D. 242	Est.	Obs.
0993.6	12.4	Ba
1015.7	11.0	Pi
16.6	11.0	Ba
33.6	9.8	Ba
33.7	10.1	R
42.6	9.6	M
43.6	9.6	Ba

151714
S Serpentis

J.D. 242	Est.	Obs.
0993.6	<11.5	M
93.6	11.7	Ba
1003.6	11.7	Ba
07.7	11.4	V
15.6	11.2	Ba
16	10.5	T
18.7	11.4	V
19.6	11.1	Ba
33.6	11.0	Ba
34.7	10.6	M
36.6	10.7	V
43.6	10.4	Ba

151731
S Cor. Bor.

J.D. 242	Est.	Obs.
0986.6	10.2	Bu
90.6	9.6	B
93.6	10.0	O
93.6	9.1	Ba
1003.7	10.0	Ba
04.6	10.2	Hu
08.6	10.6	Pi
10.6	9.9	B
11.6	10.7	M
11.7	10.5	Bl
11.7	10.5	Mu
11.7	10.5	G
15.6	10.4	Ba
19.6	10.9	Ba
19.7	10.4	Mu
19.7	10.3	R
21.7	10.4	Mu
33.6	11.3	Ba
42.7	11.9	M
43.6	12.1	Ba
44.7	12.1	Sp

151822
RS Librae

J.D. 242	Est.	Obs.
0968	8.9	L
1003.6	8.2	Ba
15.6	8.6	Ba
15.7	9.2	Pi
16.6	8.3	B
19.6	8.5	Ba
33.6	9.8	Ba
42.6	9.8	M
45.6	10.4	Ba

152714
RU Librae

J.D. 242	Est.	Obs.
0954	10.9	L
93.6	8.3	Ba
1003.7	8.3	Ba
10.7	8.2	R
11.7	8.5	M
15.6	8.4	O
15.6	8.5	Ba
15.7	8.2	Pi
16.6	8.1	B
19.6	8.5	Ba
25.7	8.6	R
33.6	8.8	Ba
42.6	9.4	M
43.6	9.3	Ba

153215
W Librae

J.D. 242	Est.	Obs.
1042.6	10.3	M

153378
S Urs. Min.

J.D. 242	Est.	Obs.
0985.7	8.5	Mu
86.6	8.6	Bu
86	8.7	L
91.7	8.5	Ba
91.7	8.4	Mu
1003.7	8.4	Ba
04.7	8.4	Mu
08.7	8.8	M
08.7	8.5	Mu
10.7	8.8	R
10.7	9.2	Pi
11.7	8.5	G
11.7	8.8	Bl
11.7	8.4	Mu
15	9.6	Nt
15.6	8.4	Hu
15.6	8.7	Ba
17.6	8.6	B
19.6	8.5	Ba
19.7	8.6	Mu
21.7	8.7	Mu
25.7	7.7	R
27.6	8.7	Ba
28.7	9.0	M
31.7	8.7	Mu
32.7	8.7	Mu
33	8.8	T
35.6	8.9	Ba
35.7	8.7	Mu
35	9.0	T
43.6	9.6	Pi
45.6	8.9	Ba

154428
R Cor. Bor.

J.D. 242	Est.	Obs.
0954	6.1	L
68	6.0	L
74	6.0	L
81.7	5.7	R
82	6.0	L
82.8	5.8	R
84.7	6.0	Lu
85.6	6.0	Cr
85.7	5.9	Lu
85.7	6.0	Mu
86.6	5.9	Bu
86.7	5.8	Lu
86	6.0	L
87.7	6.0	Bl
87.8	6.0	E
87.8	6.1	Mu
88.5	5.9	Nt
88.6	6.1	Ma
88.6	6.1	Cr
88.7	6.2	Mu
88.8	5.9	Lu
89.7	6.0	Bl
89.7	6.1	V
89.8	5.5	R

R Cor. Bor.

J.D. 242	Est.	Obs.
0991.7	5.9	Mu
91.7	6.0	Lu
91.7	6.1	Ma
91.7	6.0	Ba
92.7	5.8	R
92.7	6.0	Mu
93.5	5.9	Nt
93.6	6.0	O
93.6	5.9	Ba
93.8	6.2	Lu
94.7	6.1	Mu
94.7	6.0	Lu
95.6	5.8	Ba
95.6	6.0	O
95.7	6.2	G
96.6	6.0	Cr
96	6.0	L
97.7	5.9	Lu
98.8	6.0	Lu
1000.7	5.9	Lu
1002	6.0	Wh
02.6	6.0	O
02.6	5.8	M
02.9	6.0	Lu
03.6	5.8	Ba
03.8	6.1	Mu
04.6	5.5	Hu
04.6	6.0	O
04.6	5.8	Ba
04.7	6.0	Mu
04.7	6.1	Lu
05.6	6.0	O
05.6	5.8	Ba
05.7	6.0	Bl
05.7	6.0	Lu
06.7	5.6	R
06.8	6.1	Mu
07.6	6.2	Ma
07.7	6.4	V
07.7	6.0	G
08.6	6.0	Pi
08.7	6.0	Mu
08.7	6.1	Lu
09.6	<6.0	S
09.6	6.0	O
09.7	5.5	R
09.8	6.1	Mu
10.6	6.0	Ba
10.7	5.8	R
10.8	6.1	Mu
11.7	6.0	Bl
11.7	6.1	Mu
11.7	6.1	G
13.6	6.0	O
13.7	5.7	R
14.7	6.0	Bl
14.7	5.7	R
14.7	6.0	Mu
15	5.9	Nt

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued.

R Cor. Cor.			R Cor. Bor.			R Serpentis			160118 R Herculis			161138 W Cor. Bor.		
J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.
1015.6	5.9	Sc	1043.6	5.9	Ba	1037.6	8.7	O	0989.7	11.0	V	0990.6	11.9	B
15.6	6.0	Ba	44	6.3	Gr	37.6	8.6	Ma	93.7	11.2	Ba	93.7	<12.5	Ba
15.6	6.0	O	44.6	5.8	Ba	42.6	9.0	Wpi	1005.6	12.0	Ba	1010.6	12.2	B
15.8	6.0	M	45	6.0	Gr	42.6	8.8	Pi	08.6	12.0	B	33.6	11.3	Ba
16.6	6.0	O	45.6	5.8	Ba	43.6	8.8	O	15.6	11.9	Hu	37.6	11.2	Ba
16.6	6.2	Ma	45.6	6.0	O	43.6	9.0	Ba	15.6	12.9	Ba	45.6	11.1	Ba
16.6	6.0	Ba	45.6	6.0	Cr	46.6	9.0	O	37.6	13.4	Ba			
16.8	6.1	Mu	45.6	6.0	O	51.6	9.3	O	37.7	<10.7	M	*161607* W Ophiuchi		
17.6	6.0	O	51.6	6.0	O							1004.6	11.3	Ba
17.8	6.1	Mu				*154736*			160210			15.6	<13.0	Ba
18.7	5.6	R	154536			R Lupi			U Serpentis			37.6	<13.5	Ba
19.6	6.0	O	X Cor. Bor.			1033.6	10.1	Ba	0991.7	11.0	Ba			
19.6	6.0	Cr	0991.7	11.1	Ba				1003.7	11.6	Ba	*162112* V Ophiuchi		
19.6	6.1	V	1003.7	10.9	Ba	154715			04.6	11.1	O	0993.7	7.9	Ba
19.6	6.0	Ba	15.6	9.7	Ba	R Librae			05.7	11.4	Pi	1004.6	8.0	Ba
19.6	5.9	Hu	19.6	9.5	Ba	1034.7	<11.2	M	15.6	11.8	Ba	08.8	8.8	M
19.7	5.9	Mu	28.6	8.9	Ba				15.6	9.1	M	15.6	8.0	Ba
19.7	5.7	R	35.6	9.1	Ba	*155918*			16.6	11.8	B	33.7	10.0	R
20.7	6.0	Mu	43.6	9.0	Ba	RR Librae			37.6	13.0	B	35.7	8.6	Ba
20.7	5.5	R				1011.7	9.0	M	37.6	12.8	Ba	43.6	8.5	Ba
21.7	5.9	Mu	154639			42.7	9.1	M						
23.8	6.1	Mu	V Cor. Bor.						*160221*			162119 U Herculis		
24.8	6.1	Mu	0986.6	8.9	Bu	155229						0993.7	8.9	Ba
27.6	6.0	Ba	93.7	8.8	Ba	Z Cor. Bor.			0989.8	<11.1	M	1004.6	8.3	Ba
28.6	6.1	Ba	1003.7	9.2	Ba	0993.7	13.0	Ba				04.7	8.3	Mu
31.6	6.0	M	15.6	9.1	Ba	1015.6	<13.6	Ba	160625 RU Herculis			05.6	8.3	O
31.7	6.0	Mu	15.8	10.1	M	35.6	<13.0	Ba	0989.7	11.1	V	07.6	8.2	Ma
32.3	6.1	Ba	19.6	9.3	Ba				91.8	10.6	M	08.6	8.4	Pi
32.6	6.2	Wpi	28.6	9.1	Ba	155847			93.7	10.8	Ba	09.6	8.0	O
32.7	6.0	Mu	31.6	10.3	M	X Herculis			1003.7	10.8	Ba	09.6	8.3	S
32.7	5.8	R	35.6	9.9	Ba	0988	6.9	Nt	08.6	10.7	V	11.7	7.5	Mu
33.6	6.1	Ba	43.6	9.5	Ba	1004.7	6.7	Mu	15.6	9.8	B	11.7	8.0	M
33.6	6.5	Sc				11.7	6.8	Mu	15.6	10.7	Ba	11.7	7.9	Bl
33.7	5.9	R	154615			11.7	6.0	G	19.7	10.6	V	11.7	7.5	G
33.8	6.1	Mu	R Serpentis			14.7	6.8	Mu	27.6	9.6	Ba	13.6	7.9	O
34.7	6.0	Mu	0991.7	7.3	Ba	15	7.1	Nt	33.6	8.6	Ba	13.7	8.1	R
35.6	6.1	Ba	93.6	7.6	M	19.7	6.4	Mu	36.7	8.3	Wpi	15.6	7.4	Ba
35.7	6.1	Mu	93.6	8.0	O	19.7	5.3	R	36.7	8.4	Pi	15	7.7	Nt
35.8	6.2	E	95.6	8.0	O	20.7	6.4	Mu	36.7	8.5	V	15.6	7.4	B
36.6	6.0	Ma	1003.7	7.6	Ba	21.7	6.5	Mu	38.7	8.3	M	15.8	7.7	M
36.6	6.0	Pi	04.6	8.0	O	31.7	6.3	Mu	43.6	7.9	Ba	16.6	7.6	Ma
36.7	6.5	V	05.7	8.1	Pi	32.7	6.5	Mu				17.6	7.7	O
36.7	6.0	Mu	09.6	8.1	O	33.7	5.4	R				17.6	7.4	Cr
37.6	6.0	O	11.7	7.2	Bl	33.8	6.5	Mu				17.7	7.6	Sc
37.6	6.1	Ba	13.6	8.1	O	34.7	6.5	Mu	*161122a* R Scorpii			19.6	7.2	Mu
37.8	6.3	Mu	13.7	8.1	R	35.7	6.5	Mu	1004.7	11.0	M	21.7	7.0	Mu
38.7	6.1	Mu	15.6	7.9	Ba	36.7	6.5	Mu	18.7	11.4	M	25.7	7.7	R
38.8	6.0	E	16	8.4	T	37.8	6.5	Mu				27.7	7.2	Ba
39.7	6.2	Mu	16.6	8.1	B	38.7	6.3	Mu				32.7	7.1	Mu
39.8	6.1	E	16.6	8.2	Ma	41	7.1	Nt	*161122b* S Scorpii			35.7	7.1	Ba
40.6	6.1	Ma	17.6	8.2	O	44	6.5	Nt	1004.7	11.2	M	35.7	7.0	Mu
40.7	5.6	R	19	9.0	T				18.7	11.3	M	36.6	7.2	Ma
41.6	5.9	Ba	19.6	8.0	Ba	*160021*						36.6	7.8	Wpi
41.6	6.5	Sc	21.7	8.1	Mu	Z Scorpii			*161122c* T Scorpii			36.6	7.4	Pi
41.7	5.8	R	25.7	8.7	R	0989.8	10.6	M	1004.7	10.8	M	37.6	7.1	O
41.8	6.0	E	27.6	8.3	Ba				18.7	11.0	M	37.7	7.2	M
42.6	6.0	Pi	32.7	8.5	Mu	160127						43.6	7.1	Ba
42.7	6.0	M	34.7	8.2	M	RR Herculis						43.6	7.7	O
43.6	6.0	O	35.6	8.7	Ba	016	8.4	T						

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued

U Herculis

J.D. 242	Est.	Obs.
1045	7.2	Gr
46.6	7.6	O
51.6	7.8	O

162807
SS Herculis

0993.7	12.0	Ba
1004.6	11.1	Ba
08.6	11.3	B
10.7	10.9	Ba
15.6	10.9	Ba
27.7	9.9	Ba
33.7	9.8	Ba
36.7	9.3	V
38.7	9.7	M
41.6	9.4	Ba

162815
S Ophiuchi

1004.6	10.0	Ba
15.6	10.7	Ba
37.6	12.2	Ba

163137
W Herculis

0991.8	9.2	M
93.6	9.2	O
93.6	9.0	Ba
1003.7	9.0	M
04.6	9.7	Ba
08.6	9.7	B
09.6	9.5	Hu
09.6	9.5	S
15.6	10.0	Ba
17.6	9.7	O
27.7	10.5	Ba
35.7	11.2	Ba
36.7	11.4	Wpi
36.7	11.2	Pi
44.6	11.8	Ba

163172
R Urs. Min.

0993.7	9.1	Ba
1004.6	9.1	Ba
08.7	9.9	M
10.7	9.4	Pi
15.6	9.3	Ba
17.6	9.3	B
19.7	9.6	R
25.7	9.6	R
27.7	9.5	Ba
28.7	9.4	M
37.6	9.2	Ba
43.6	9.8	Pi
45.6	9.3	Ba

163266
R Draconis

J.D. 242	Est.	Obs.
0985.6	7.9	Cr
88.6	7.7	Ma
91.7	7.9	Ba
91.8	7.9	M
93.6	7.7	O
95.6	8.0	Ba
95.6	7.7	O
96.6	7.8	B
96.6	7.9	Cr
1001.6	7.9	Pi
02	8.2	Wh
04.6	8.4	Ba
05.6	8.0	Cr
07.6	8.1	Ma
08.7	8.8	M
09.6	9.0	S
09.6	8.7	O
10.6	8.5	Cr
13.6	8.8	O
13.7	8.8	R
15.6	8.8	Ba
16	8.7	T
16.6	9.0	S
17.6	9.1	O
17.6	9.3	Cr
19	9.2	T
25.7	9.8	R
27.6	9.6	M
27.7	9.5	Ba
33	9.6	Wh
35.6	9.8	S
35.7	10.2	Ba
44.6	10.8	Ba

164055
S Draconis

0991.8	8.5	M
1003.7	8.8	M
04.6	8.9	Ba
08.7	8.9	M
13.7	9.0	R
27.7	9.0	M
28.6	8.1	Ba
33.7	9.3	R

164319
RR Ophiuchi

1004	<12.0	Ba
1016.6	12.7	B
	16.7<13.0	Sp
44.7	12.9	B

164715
S Herculis

0991.8	8.0	M
93.7	7.9	Ba
1004.6	8.4	Ba
05	9.0	Wh
05.6	9.2	O

S Herculis

J.D. 242	Est.	Obs.
1008.6	8.7	B
08.6	9.0	Pi
13.6	9.5	O
13.7	9.1	R
15.6	9.0	Ba
17.6	9.5	O
27.7	9.9	Ba
33.7	10.0	R
34.7	10.0	M
35.7	10.1	Ba
37.6	10.0	O
44.6	10.5	Ba
45.6	10.1	O

165030
RR Scorpii

1010.8	11.3	Pi
33.7	<10.5	R
45	10±	T

165631
RV Herculis

0991.8	<11.2	M
93.7	<13.7	Ba
1004.6	<13.6	Ba
04.7	14.4	M
08.6	<13.6	B
14.8	14.2	M
35.7	<13.5	Ba
40.7	<13.7	M

170215
R Ophiuchi

0954	6.6	L
1004.6	8.1	Ba
05.7	8.2	Pi
08.7	8.1	M
11.7	8.0	Bl
14.7	8.7	R
15.6	8.3	O
15.6	8.4	Ba
16.7	8.4	Sp
27.7	9.0	Ba
33.7	9.3	R
35.7	9.8	Ba
36.6	9.1	Ma
38.7	9.5	M
43.6	10.4	Pi
44.6	10.0	Ba

170627
RT Herculis

0995.6	10.7	Ba
1004.7	10.7	Ba
08.6	11.1	B
15.6	10.9	Ba
28.7	11.0	Ba
35.7	11.3	Ba
37.8	11.4	M
44.6	11.5	Ba

171401
Z Ophiuchi

J.D. 242	Est.	Obs.
0989.7	8.4	V
95.6	8.5	Ba
1004.6	9.0	Ba
07.7	9.0	V
15.6	9.0	Ba
19.7	9.0	V
28.6	9.1	Ba
36.7	9.0	V
44.6	9.0	Ba
46.6	8.9	O

171723
RS Herculis

0989.7	8.4	V
95.6	7.9	Ba
1004.6	7.9	Ba
07.7	7.8	V
08.6	7.7	Pi
09.6	7.5	Hu
12.8	7.8	M
14.7	8.1	R
15.6	8.0	B
15.7	7.9	Ba
17.6	8.0	O
19	7.8	V
27.7	8.1	Ba
33.7	8.5	R
35.7	8.5	Mu
35.7	8.1	Ba
36.6	8.7	Pi
36.6	8.7	Wpi
36.7	8.4	V
37.6	8.8	O
38.7	8.6	M
40.7	8.7	M
43.6	9.1	O
44.6	8.5	Ba
44.7	8.9	M

172809
RU Ophiuchi

0989.8	9.1	V
91.8	9.3	M
95.6	9.0	Ba
1004.6	9.2	Ba
07.7	10.0	V
11.8	9.4	E
15.7	9.4	Ba
16.7	9.5	Sp
19.7	<9.6	V
28.6	10.0	Ba
34.7	11.0	M
35.7	11.0	E
36.7	<11.2	V
40.7	11.1	R
44.6	11.4	Ba

175111
RT Ophiuchi

J.D. 242	Est.	Obs.
0989.8	<11.0	V
1004.7	12.5	Ba
11.7	9.7	M
15.7	13.0	Sp
16.6	12.9	B
16.6	<12.5	Ba
38.7	<13.0	Sp
44.7	<13.0	Sp

175458
T Draconis

0989.8	<11.0	V
91.8	<10.4	M
1004.7	12.7	Ba
04.7	11.1	M
10.7	11.2	Pi
28.6	12.5	Ba
31.6	9.5	M
36.7	<10.4	V
44.6	11.6	Ba

175519
RY Herculis

1008.7	13.0	Ba
28.6	11.1	Ba
33.7	10.5	Ba
44.6	9.6	Ba

180531
T Herculis

0991.8	10.6	M
1004.7	11.5	Ba
10.6	11.1	Ba
15.6	10.8	O
21.6	9.6	Sc
28.6	9.3	Ba
34.7	9.5	M
35.7	9.3	Mu
37.6	9.1	O
37.6	8.8	Ma
40.7	9.5	R
43.6	8.7	O
44.6	8.4	Ba
51.6	8.5	O

180565
W Draconis

0991.8	<12.0	M
1001.6	<11.3	Pi
04.7	<12.5	Ba
10.6	13.0	B

180666
X Draconis

0991.8	10.7	M

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued.

181103
RY Ophiuchi

J.D. 242	Est.	Obs.
0989.8	8.0	V
1004.7	10.0	Ba
07.7	10.2	V
16.6	11.1	B
16.7	11.3	Sp
19.7	<11.7	V
36.7	<11.3	V
37.7	10.5	M
44.7	13.0	Ba

181136
W Lyrae

1003.6	12.6	B
04.7	12.3	M
04.7	12.6	Sp
05.6	<10.9	O
05.6	12.2	Ba
08.7	11.9	Sp
10	<10.5	Wh
15.6	11.8	Hu
17.7	11.9	Sp
19.6	11.9	Hu
21.7	11.3	Mu
27.6	11.0	M
31.7	10.6	M
32.7	11.2	Mu
35.6	10.3	B
35.6	10.5	Sc
35.7	11.2	Mu
1037.6	10.1	Hu
43.6	9.9	O
43.6	10.3	M
44.7	10.1	Ba
51.6	5.9	O

182224
SV Herculis

1008.6	12.3	B
16.7	11.7	Ba
28.6	10.3	Ba
33.7	10.4	Ba
44.6	9.8	B
44.7	9.9	Ba

182306
T Serpentis

1004.7	9.1	Ba
07.7	9.4	V
15.9	9.6	M
19.7	9.3	V
28.6	9.6	Ba
34.7	9.2	M
36.7	10.2	V
40.7	10.0	R
44.7	9.7	Ba

183225
RZ Herculis

1011.8	12.2	E
16.7	<12.5	Ba
17.6	<10.6	O
33.7	12.7	Ba
44.7	13.0	Ba

183308
X Ophiuchi

J.D. 242	Est.	Obs.
0954	8.1	L
89.8	8.4	V
1004.7	8.3	Ba
07.7	8.5	V
08.6	8.5	Pi
08.7	8.2	M
15.7	8.4	Ba
19.7	8.4	V
27,7	8.2	Ba
33.7	8.1	Ba
36.7	8.4	V
37.6	8.4	Ma
37.7	8.1	M
40.7	8.3	R
41.6	8.0	Ba
44.7	7.8	Sp
45.6	8.0	Ba

184134
RY Lyrae

1019.6	<13.0	Ba

184243
RW Lyrae

1008.8	<13.7	Sp
08.7	<13.4	B
11.8	13.1	E
28.6	<13.0	Ba
44.6	<13.7	B

184205
R Scuti

0954	5.6	L
68	5.0	L
82	5.0	L
91.9	5.3	M
92.7	5.2	Pi
93.7	5.4	Ba
1004.7	5.7	Ba
08.8	5.2	M
10.6	5.9	Ba
10.8	5.5	Pi
11.8	5.9	E
15.6	5.9	Ba
15.6	5.7	Nt
19.6	5.9	Ba
27.6	5.6	Ba
28.6	5.7	Ba
32.8	5.3	M
33.6	5.7	Ba
35.6	5.8	Ba
35.8	6.0	Mu
35.8	5.5	E
37.6	5.6	Ba
37.8	6.0	Mu
38.8	5.4	E
39.8	5.9	E
40.6	5.5	Ma
40.7	4.9	R
41.6	5.7	Ba

R Scuti

J.D. 242	Est.	Obs.
1041.8	5.9	E
43.6	6.0	O
43.6	5.7	Ba
44.6	5.2	Pi
44.6	5.7	Nt
44.7	5.6	Ma
45.6	6.0	O
45.6	5.8	Ba
46.6	6.0	O
51.6	6.4	O

185032
RX Lyrae

1010.6	13.8	Ba
14.8	14.3	M
41.6	<14.0	Ba

190108
R Aquilae

0991.9	9.9	M
1004.7	9.6	Ba
08.8	9.4	M
15.7	9.1	Sp
17.7	8.5	Sp
27.7	8.4	Ba
34.8	8.2	M
36.7	8.0	V
37.7	7.5	Sp
44.7	7.0	Ba

190529
V Lyrae

0993.7	10.6	Ba
1004.7	11.1	Ba
15.6	12.0	Pi
41.6	12.2	Ba

190926
X Lyrae

0995.6	9.1	Ba
1003.8	9.5	M
04.7	8.9	Ba
08.6	9.2	Pi
15.6	9.5	Pi
28.6	9.0	Ba
37.6	8.7	Ba
37.7	9.4	Ma
38.7	9.3	M
40.7	9.2	R
43.6	9.7	M
45.6	9.0	Ba
46.6	9.2	O

190967
U Draconis

0991.8	<12.1	M

191019
R Sagittarii

1010.8	11.4	Pi
11.1	10.2	Ho
44.7	8.7	Ba

191033
RY Sagittarii

J.D. 242	Est.	Obs.
1010.8	<10.6	Pi
11.9	<8.3	E
11.9	<11.5	Ho
37.7	<12.0	Ba
41.7	<12.0	Ba

191350
TZ Cygni

1005.7	10.2	Ba
23.6	10.4	Ba
43.7	10.5	Ba

191637
U Lyrae

1004.7	10.6	Ba
15.6	11.1	Pi
15.7	10.3	Ba
28.7	10.0	Ba
38.7	10.6	M
43.7	9.4	Ba

192928
TY Cygni

0995.6	10.0	Ba
1003.8	8.7	M
04.7	9.6	Ba
07.8	10.3	V
11.8	10.3	E
19.7	10.8	V
28.7	11.5	Ba
42.8	<11.2	V
43.6	10.0	M
43.7	12.0	Ba

193311
RT Aquilae

1004.7	9.1	Ba
15.7	9.0	Ba
16.6	9.6	O
28.7	9.2	Ba
28.8	8.0	M
43.6	9.9	O
43.7	9.1	Ba

193449
R Cygni

0989.8	9.8	M
95.6	9.0	Ba
97.7	9.0	Pi
1004.7	8.8	Ba
11.8	9.1	E
13.7	8.5	R
15.6	8.4	S
15.6	8.4	O
17.6	7.9	B
19.6	8.7	O
20.8	8.1	M
21.8	8.0	Mu
27.7	8.4	M
28.7	7.2	Ba

R Cygni

J.D. 242	Est.	Obs.
1029.7	7.2	R
34	7.3	Wh
34.6	7.5	Pi
35.6	7.5	S
35.7	7.2	Mu
36.6	7.4	Ma
37.6	7.2	O
37.6	7.5	Cr
41.6	7.2	R
43.6	7.0	O
43.6	8.4	M
43.6	7.1	Ba
45	8.7	T
51.6	6.9	O

193509
RV Aquilae

1004.7	9.5	Ba
11.8	9.9	E
16.7	9.7	O
28.7	10.8	Ba
41.7	12.1	M
43.6	<10.5	O
43.7	12.2	Ba

193732
TT Cygni

0982	7.2	L
93.6	7.8	Pi
97.6	7.3	Ba
1004.7	7.2	Ba
08.8	8.2	M
11.8	8.1	E
19.7	8.0	R
28.7	7.2	Ba
34.6	8.2	Pi
42.6	8.1	Ma
43.6	8.1	M
44.7	7.4	Bu

194048
RT Cygni

0989.8	7.2	M
93.6	7.2	Pi
95.6	7.4	Ba
1004.7	7.7	Ba
11.8	7.7	E
13.7	8.1	R
15.6	8.0	O
15.6	8.3	S
15.7	8.0	Ba
19.6	8.2	O
20.8	8.4	M
21.8	8.2	Mu
25.7	8.8	R
27.7	8.7	M
28.7	8.5	Ba
34	9.0	Wh
35.6	9.1	S
35.8	9.1	Mu

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued.

RT Cygni

J.D. 242	Obs.	Est.
1037.6	9.3	Ma
37.6	9.1	O
43.6	9.3	Ba
43.6	9.6	O
43.6	9.8	M
45	11.2	T
51.6	9.7	O

194348

TU Cygni

0989.8	<11.2	M
1004.7	12.8	M
04.7	12.5	Ba
11.8	11.3	E
15.6	11.0	O
15.7	11.2	Ba
19.6	10.6	O
28.7	10.2	Ba
28.8	10.3	M
43.6	9.6	M
43.6	10.0	Ba

194604

X Aquilae

0989.8	9.9	V
91.9	9.3	M
95.8	9.3	Pi
1004.7	8.8	Ba
07.8	8.8	V
08.8	9.5	M
15.7	9.1	Sp
19.7	8.8	V
28.7	9.2	Ba
28.8	10.0	M
37.7	10.0	Sp
41.7	9.9	M
42.6	10.4	Pi
42.6	10.5	Wpi
42.8	9.9	V
43.7	9.7	Sp
44.7	9.8	Ba

194632

χ Cygni

0982	10.3	L
89.8	10.6	M
1005.7	11.0	Ba
11.8	11.4	E
15.6	11.0	O
15.7	11.5	Sp
15.7	11.4	B
17.7	12.0	Sp
19.7	<11.0	R
37.7	12.1	B
41.6	12.3	Ba

195116

S Sagittae

1035.8	5.4	Mu
37.8	5.7	O
43.6	5.8	O
46.6	5.9	O
51.6	5.9	O

195849

Z Cygni

J.D. 242	Obs.	Est.
0989.8	<11.6	M
97.7	12.2	Pi
1004.7	12.5	M
04.7	12.5	Ba
10.7	12.2	Sp
17.6	12.5	B
17.7	12.3	Sp
21.8	<11.6	Mu
34.6	<11.6	Pi
35.7	12.5	Sp
37.6	12.5	B
41.6	12.7	Ba
43.6	11.6	M

200212

SY Aquilae

0991.9	10.7	M
1004.7	11.0	Ba
38.7	11.6	Sp
38.7	11.6	B
41.6	11.8	Ba
41.7	11.9	M
46.6	<10.8	O

200357

S Cygni

0997.7	<11.7	Pi
1004.8	14,1	M
15.7	<13.5	Sp
37.7	<13.5	Sp
41.6	<14.0	Ba
45.6	<10.7	O

200514

R Capricorni

1041.7	10.4	M

200647

SV Cygni

0989.8	9.0	M
95.6	8.8	Ba
95.7	8.8	Pi
1004.7	8.1	Ba
20.8	8.8	M
21.8	8.9	Mu
27.7	9.0	M
28.7	8.2	Ba
29.7	9.1	R
34.6	9.0	Pi
34.6	8.7	Wpi
35.8	9.1	Mu
41.6	9.2	Cr
43.6	9.3	Pi
44.7	9.2	Ma
44.7	8.0	Ba
45.6	9.1	Cr

200715a

S Aquilae

J.D. 242	Obs.	Est.
0991.9	9.6	M
1004.7	9.5	Ba
16.7	9.7	Sp
28.7	9.5	Ba
37.7	9.8	Sp
41.7	10.7	M
43.7	10.1	Sp
44.7	9.9	Ba

200915b

RW Aquilae

0991.8	8.8	M
1004.7	9.4	Ba
16.7	9.6	Sp
28.7	9.1	Ba
37.7	9.0	Sp
41.7	8.9	M
43.7	9.0	Sp
44.7	9.1	Ba

200747

RX Cygni

1021.8	7.8	Mu
35.8	7.8	Mu
45.6	7.8	O

200822

W Capricorni

1015.9	<11.6	M

200812

RU Aquilae

1004.7	9.6	Ba
45.6	9.6	O

200916

R Sagittae

0991.9	9.9	M
1004.7	9.7	Ba
16.7	8.6	Sp
28.7	8.9	Ba
37.7	9.1	Sp
41.7	8.7	M
43.7	9.0	Sp
44.7	9.0	Ba

200906

Z Aquilae

1041.7	13.0	Ba
43.7	13.5	Sp

200938

RS Cygni

0982	7.0	L
89.8	8.5	M
1005.7	7.1	Ba
10.7	8.0	Pi
14.7	8.4	R
20.8	8.3	M
29.7	7.3	R
36.7	8.3	Wpi
36.7	8.6	Pi
41.6	8.0	Ma
41.7	7.3	Ba
43.6	8.7	M

201008

R Delphini

J.D. 242	Est.	Obs.
1005.7	10.3	Ba
41.7	12.0	B
41.7	12.0	Ba
44.6	<10.4	Pi
45.6	<10.8	O

201121

RT Capricorni

1011.1	7.0	Ho
15.9	7.7	M
37.7	7.0	Ba
42.7	7.4	M

201139

RT Sagittarii

0982.1	7.8	Ho

201130

SX Cygni

0989.8	<11.4	M
1010.7	13.5	Sp
14.8	13.0	M
16.7	13.0	Ba
17.7	12.7	Sp
17.7	12.8	B
35.7	10.3	Sp
36.7	10.9	B
40.7	13.7	M
43.7	10.2	Sp
44.7	10.2	Ba

201647

U Cygni

0982	9.8	L
89.8	9.2	M
91.7	7.6	Ba
95.7	8.5	Pi
1004.7	7.8	Ba
14.7	9.6	R
15.6	9.5	S
20.8	9.4	M
21.8	9.4	Mu
27.7	9.7	M
35.6	8.6	Cr
35.8	9.5	Mu
37.6	9.8	S
37.6	8.8	Cr
39.6	9.5	Bu
39.6	9.5	Cr
41.6	9.4	Cr
41.6	8.0	Ba
43	8.2	Wh
43.6	10.0	Pi
44.7	10.2	M
45.6	9.0	O
45	11.1	T

202539

RW Cygni

0989.8	8.9	M
97.7	8.2	Pi
1004.7	7.8	Ba

RW Cygni

J.D. 242	Est.	Obs.
1020.8	8.1	M
31.7	8.0	M
33	8·0	Wh
37.6	8.3	Ma
41.7	7.6	Ba
44.7	7.9	Cr

202817

Z Delphini

0989.8	10.8	V
1005.7	9.5	Ba
07.8	9.5	V
19.7	9.0	V
42.7	9.3	M
42.8	9.4	V
43.7	8.9	Ba
44.6	9.0	Pi
45.6	9.4	O

202946

SZ Cygni

0982	10.0	L
89.8	8.9	M
91.7	9.3	Ba
93.6	9.6	Ba
97.7	9.6	Pi
1005.7	8.8	Ba
10.7	9.2	Ba
14.7	9.9	R
15.7	9.3	Ba
16.7	9.5	Ba
19.6	8.8	Ba
25.7	9.8	R
27.6	9.4	Ba
27.7	10.0	M
28.6	9.6	Ba
32.7	9.4	R
33.6	8.9	Ba
33.7	9.0	R
35.6	8.9	Ba
40.7	9.3	R
41.6	9.2	Ba
41.7	9.9	R
43.6	9.7	Ba
44.6	10.0	Ba
45.6	10.5	Cr
45.6	9.9	Ba

202954

ST Cygni

0989.9	<11.7	M
97.7	<11.0	Pi
1010.7	12.4	Sp
14.8	12.4	M
17.6	12.6	B
38.6	12.1	B
40.7	11.9	M
41.7	11.7	Ba

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued.

203226
V Vulpeculae

J.D.	Est.	Obs
242		
0992.8	8.9	Pi
1005.7	8.7	Ba
27.7	9.2	M
41.7	8.7	Ba

203611
Y Delphini

1041.7	<13.3	Ba

203847
V Cygni

1005.7	12.8	B
14.8	12.3	M
40.7	11.4	M
43.7	12.4	Ba

203905
Y Aquarii

1039.8	12.0	M

204016
T Delphini

1014.8	12.8	M
38.7	9.9	Sp
40.7	10.5	M
43.7	10.1	Ba

204405
T Aquarii

0982.1	8.1	Ho
1037.7	11.5	Ba
37.8	11.5	M

204846
RZ Cygni

1005.7	12.1	Ba
42.7	10.5	M
43.7	12.5	Ba

205017
X Delphini

1005.7	9.0	Ba
41.7	9.8	Ba
45.6	10.7	O

205923
R Vulpeculae

0989.9	8.8	M
92.8	8.8	Pi
1005.7	9.1	Ba
09.9	9.4	M
43.7	11.7	Ba

210129
TW Cygni

0989.8	<11.2	V
1045.6	10.0	B9

210116
RS Capricorni

J.D.	Est.	Obs
242		
1011.1	8.4	Ho
15.9	8.1	M
37.7	7.9	Ba
37.8	8.0	M

210868
T Cephei

0986	10.1	L
1005.7	10.4	Ba
09.9	10.7	M
10.7	10.7	Pi
35.7	10.0	Ba
42.7	10.2	M
43.6	10.1	Pi
45.6	10.0	O

211614
X Pegasi

1037.7	14.0	Ba

211615
T Capricorni

1037.7	<12.7	Ba

213044
W Cygni

0954	5.5	L
68	5.9	L
82	5.9	L
1032.7	5.9	R
45 6	5.9	O

213678
S Cephei

1005.7	8.7	Ba
09.9	9.7	M
10.7	9.8	Pi
16.6	10.2	S
19.6	9.3	Hu
37.6	10.2	S
41,7	9.4	Ba
42.7	10.3	M

213753
RU Cygni

0991.9	9.0	M
97.7	9.2	Pi
1032.8	8.8	M
41.7	6.7	Ba

213843
SS Cygni

0954	8.1	L
68	11.7	L
82	11.8	L
89.8	<10.9	M
89.8	<11.3	V
91.7	10.7	Ba
91.8	9.8	Pi
91.9	10.0	M
92.7	9.6	Pi

SS Cygni

J.D.	Est.	Obs
242		
0993.6	9.6	Pi
93.7	9.6	Ba
93.7	10.2	Bu
95.7	9.8	Bu
95.7	8.7	Pi
96.7	9.5	Bu
97.6	8.3	Pi
97.7	8.3	Pi
97.9	8.3	M
1001.6	9.1	Pi
02.8	9.7	M
03.7	10.0	Ba
93.8	10.4	M
04	10.2	Wh
04.7	10.3	Ba
04.7	10.8	M
05.7	11.3	Pi
05.7	10.9	Ba
07.8	<11.3	V
08.8	12.0	M
10	<10.9	Wh
10.7	11.6	Ba
10.7	11.8	Sp
10.8	11.7	Pi
11.8	11.7	E
15.6	11.7	Pi
15.7	11.6	Ba
15.7	11.8	Sp
15.9	12.0	M
16.6	11.6	Ba
16.7	11.7	Sp
17.7	11.7	Sp
19.6	11.9	Hu
19.6	11.3	Cr
19.6	11.5	Ba
19.7	11.1	E
19 8	11.1	V
20.8	11.3	M
25.9	10.4	M
27.6	8 7	Ba
27.7	8.3	M
28.6	8.6	Ba
28.8	8.3	M
31.7	8.4	M
32.6	8.3	Pi
32.6	8.6	Ba
32.6	8.2	Wpi
32 8	8.4	M
33	8.4	Wh
33.4	8.4	T
33.6	8.7	Ba
33.7	8.9	R
34	9.2	Wh
34.6	8.3	Cr
34.6	8.3	Pi
34.7	8.5	M
34.8	8.6	E
35.4	8.4	T
35.6	8,7	Ba

SS Cygni

J.D.	Est.	Obs
242		
1035.6	8.4	Cr
35.7	8.7	Sc
35.7	8.6	Sp
35.7	8.4	S
35.8	8.6	E
36.7	9.2	Pi
36.8	8.5	Wpi
37.4	9.3	T
37.6	9.4	S
37.6	9.1	Ba
37.6	9.7	Cr
37.6	9.0	Ma
37.6	9.1	O
37.6	9.3	Hu
37.6	9.3	B
37.7	9 3	Sp
37.7	9.3	M
38.4	10.0	T
38.6	9.5	B
38.7	9.6	Sp
38.8	9.6	M
39.6	10.1	Cr
39.6	10.1	Bu
40.7	9.9	R
40.7	10,6	M
41.3	10.7	T
41.6	10.9	Nt
41.6	10.6	Ba
41.6	10.1	M
41.6	10.9	Cr
41.6	10.5	B
41.7	10.4	Sp
41.7	10.5	R
41.8	10.3	E
42.6	10.2	M
42.6	11.5	Pi
42.6	10.9	Cr
42.6	11.5	Wpi
42.8	10.6	V
43	10.6	Wh
43.6	11.2	Ba
43.6	11.3	B
43.6	11.5	Pi
43.7	11.1	Sp
43.7	10.4	M
44	10.6	Wh
44.6	11.5	Ba
44.6	11.4	B
44.6	11.2	Cr
44.6	11.2	Nt
44.7	11.1	Sp
45.6	11.6	Ba
45.6	11.1	Cr
44	11.4	T

213937
RW Cygni

0982	6.2	L
89.8	7.8	M
97.7	7.8	Pi

RW Cygni

J.D.	Est.	Obs
242		
1010.7	6.8	Ba
32.8	7.5	M
43.7	7.2	Ma
43.7	7.4	Ba
45	8.0	T

214924
RR Pegasi

1010.7	9.2	Ba
37.7	10.2	Sp
37.7	9.8	Ba
43.7	10.2	Sp
45.6	10.0	Ba

215605
V Pegasi

1037.7	13.0	Ba

215934
RT Pegasi

0989.8	<11.3	V
1007.8	10.8	V
19.7	10.9	V
42.8	10.8	V
45.6	10.9	Ba

220412
T Pegasi

1037.7	9.8	Ba
41.8	10.4	E
45.6	10.2	Ba

220613
Y Pegasi

1041.8	<12.5	E

220714
RS Pegasi

1041.8	10.1	E

222439
S Lacertae

1010.7	8.2	Ba
41.7	9.2	Sp
41.7	9.6	Ba

225914
RW Pegasi

1037.7	12.8	Ba
40.8	12.6	M

230110
R Pegasi

1010.8	<10.1	Pi
40.8	12.4	M
41.9	<12.1	E

230756
V Cassiop

0997.8	8.8	Pi
1009.9	8.2	M
10.7	8.3	Ba
35.7	8.0	Ba
37.8	8.2	M
41.7	8.4	Sp
43.7	8.4	Ba

VARIABLE STAR OBSERVATIONS May, June, July, 1916—Continued.

231425 W Pegasi			231508 S Pegasi			233956 Z Cassiop.			235350 R Cassiop.			235939 SV Androm.		
J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.
1032.9	8.6	M	1039.9	9.4	E	1010.7	12.2	Ba	1037.7	12.7	Ba	1010.8	<11.6	Pi
37.7	8.6	Ba	233335			37.7	9.5	Ba	235525			37.7	9.6	Ba
41.9	9.5	E	ST Androm.			38.9	10.0	E	Z Pegasi					
			0997.8	9.4	Pi	45.7	9.6	Ba	1037.7	12.6	Ba			
			1034.9	9.0	E				41.9	<12.4	E			
			37.7	8.6	Ba									

	May-June	June-July
No. of observations	953	1131
No. of stars observed	188	190
No. of observers	21	21

differ widely from the mean of several, special care in the identification of the variable is urged. This does not apply to the extremely red stars where a wide range of estimates seems unavoidable.

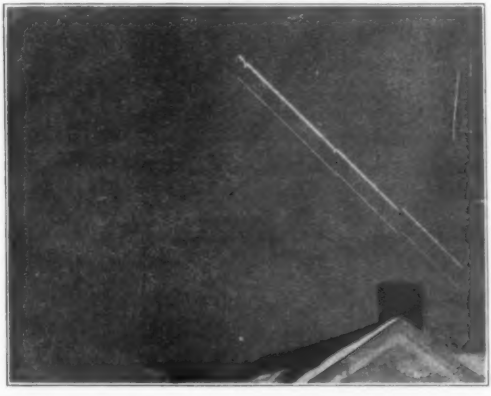
The following members contributed to this report:—Messrs. Bancroft, Baldwin, Bouton, Burbeck, Crane, Eaton, Gray, Gregory, Hoge, Hunter, Lacchini, Mach, McAteer, Mundt, Nolte, Olcott, Pickering, W. Pickering, Richter, Schulmaier, Vrooman, Whitehorn, Yendell, Miss Ludeke, and Miss Swartz.

WILLIAM TYLER OLCOTT,
Corresponding Sec'y.

Norwich, Conn.
July 10, 1916.

COMMUNICATIONS.

Conjunction of Venus and Jupiter.—This picture of Venus and Jupiter was taken from a west window at Smith College, Northampton, Mass., on Monday, February 14, 1916. The film was exposed from six forty-five until seven thirty p.m.



TRAILS OF VENUS AND JUPITER AT CONJUNCTION, FEBRUARY 14, 1916.

At this time the moon was eleven days old, half way between first and second quarter. The camera used was a Brownie 3A Folding, with ordinary magnifying

power, adjusted at stop number 64, and focussed at one hundred feet. The camera was propped up with books so as to point in the right direction and so was jarred slightly three times by the opening of the door, as indicated on the print by breaks in the trails.

Two star trails were included, one to the right and one to the left, above Venus and Jupiter, the right hand one being gamma of Pegasus, according to a map made from the sky showing the relative positions on February 15.

MARGARET R. WILSON.

1918 Cortelyou Road,
Brooklyn, N. Y.

Meteor Observations from January to June 1916.—Being interested in meteor observations and watching all other meteor observers' results that are published in POPULAR ASTRONOMY I become more interested in the work every day. I have not seen any individual meteor results published by members of the American Meteor Society and would like to hear from some so as to compare results.

My own results are as follows:

Month 1916	No. of Nights	Total Time of observation h	m	Number of Meteors	Average per hour
Jan.	6	15	20	86	5.6
Feb.	11	27	25	142	5.2
March	10	23	5	107	4.5
April	7	18	7	141	7.6
May	11	25	50	332	12.9
June	6	17	10	270	15.8

JOHN KOEP.

Chippewa Falls, Wis.

GENERAL NOTES.

The editor is back at his desk after a very enjoyable semester spent at Harvard University. It has been a great pleasure not only to renew old acquaintances but to make many new ones, and to become familiar with the workings of a great institution, especially in astronomical lines, both of instruction and of research. To see the historic instruments of Harvard College Observatory and to actually use some of them, especially to see and make actual use of some of the enormous collection of photographs which has been accumulated there in the past 30 years, the value of which increases with each year that elapses, has been a privilege greatly appreciated.

It was our privilege also to visit the observatories at Wellesley, Mt Holyoke, Northampton and Amherst, and see the splendid equipment which all of these have for instruction in astronomy. One cannot help believing that such efficient teaching of astronomy in the colleges is bound to result in more wide spread popular interest in the subject in the near future.

Dr. Karl Schwarzschild, Director of the Potsdam Observatory, has died at Brussels at the early age of forty-three years. Dr. Schwarzschild was for a time in charge of the meteorological service at Brussels since its occupation by the German army. Later however he was transferred to the artillery and his death is said to be due to disease contracted while in service at the front.

Dr. Henry Norris Russell, Director of the Princeton Observatory, has been elected an Associate of the Royal Astronomical Society. No less than five American astronomers have been accorded this rare honor in the last three years.

Observatory Given to the Case School of Applied Science.—From the Cleveland *Plain Dealer* of June 29 we learn that the observatory owned by Ambrose Swasey and W. R. Warner is to be given to the Case School of Applied Science. The observatory now stands on Euclid avenue near east 79th street, between the home of Mr. Swasey and the adjoining house formerly occupied by Mr. Warner. It will be moved to the Case School campus, University Circle. The building will be enlarged by the building of two wings, one to be used as a laboratory for the measuring instruments, the other to contain a library and sleeping quarters for a student or professor. Mr. Warner and Mr. Swasey are to build these wings and equip them.

"The history of the observatory is as interesting as the instruments which it houses. It was built twenty-five years ago when Mr. Warner and Mr. Swasey first directed their attention to the manufacture of scientific instruments. It soon became a neighborhood center for those who are interested in the study of the heavens. Small classes met at the building for the study of astronomy.

"In addition to the use which will be made of the observatory in school work, the public will be admitted to it on certain nights each week."

NOTES FROM THE YERKES OBSERVATORY.

Mr. Georges Van Biesbroeck left the Observatory on June 15 after ten months of active participation in the regular work of the Observatory, chiefly in micrometric and photographic observations. He visited several observatories on his way to New York, whence he sailed on June 28. He hopes to be able to return to the Observatory at Brussels and resume his work there, desiring also to share with his family all the inconveniences caused by the war.

Mr. F. P. Leavenworth, of the University of Minnesota, is spending the summer at the Observatory as Professor of Practical Astronomy. He is chiefly engaged on micrometric work on double stars.

During the summer quarter **Mr. Everett I. Yowell,** of the Cincinnati Observatory, is acting as volunteer research assistant and is principally engaged in work on stellar parallax with the 40-inch telescope.

Miss Frances Lowater of the Department of physics, Wellesley College, is serving as volunteer research assistant for the summer quarter in work with Mr. Frost on the spectra of certain variable stars.

Mr. O. H. Truman of the Department of Astronomy, Iowa State University, is working in celestial photography and spectroscopy.

Mr. Max Petersen, graduate student in the Department of Physics, University of Wisconsin, is working on solar physics chiefly with the spectroheliograph.

Mr. C. C. Crump, of Carleton College is working during the summer quarter as assistant in stellar spectroscopy.

Miss Evelyn Wickham, who graduated from Vassar College in June, has begun her work as computer of stellar parallax at the Observatory.

Miss Vera M. Gushee, one of the graduates of 1916 from Smith College, begins similar work this month, and in September **Miss Hannah B. Steele,** recently research assistant at Swarthmore College, will begin her work here as assistant for stellar parallax.

ILLUSTRATED LECTURES

at the Yerkes Observatory on Monday Evenings during the summer at 7:30 p. m. in July; thereafter at 7:00 p. m.

July 17	MR. O. J. LEE: Solar Prominences.
July 24	MR. E. E. BARNARD: Visual and Photographic Observations of Planets and Satellites.
July 31	MR. J. A. PARKHURST: Applications of Photographic Photometry: The Yerkes Actinometry; The North Polar Sequence.
Aug. 7	MR. E. E. BARNARD: The Star Clusters.
Aug. 14	MR. E. B. FROST: Peculiarities among Stellar Spectra.
Aug. 21	MR. C. C. CRUMP: Spectroscopic Binaries.
Aug. 28	MR. F. P. LEAVENWORTH: Notable Double Stars.
Sept. 4	MR. E. P. HUBBLE: The Nebulae.

PRELIMINARY LIST OF TOPICS PROPOSED FOR DISCUSSION AT THE MEETINGS OF THE YERKES ASTRONOMICAL CLUB IN JULY AND AUGUST 1916.

The Variability of the Sun (Abbot et al).	MR. LEMKOWITZ.
Magnetic Field in Sunspots and the general Magnetic Field of the Sun (Hale et al).	MR. PETERSEN.
The Stark Effect and its Possible Bearing on Stellar Spectra	MR. HUBBLE.
Temperature of Stars as indicated by their Spectra	MISS LOWATER.
Determination of Distances of Stars based upon their Spectra (Adams)	MR. CRUMP.
Kapteyn's "Plan of the Selected Areas" and its present Status	MR. YOWELL.
The Solar Apex	MR. TRUMAN.
Symposium on Stellar Proper Motions.	

CURRENT REPORTS.

"A Small Star with a Large Proper Motion"	MR. BARNARD.
Baillaud's Surface Photographic Photometer	MR. PARKHURST.
The Spectroscopic Binary 66 Eridani	MR. FROST.
Observations of the Radial Velocity of Gamma Lyrae	MR. CRUMP AND MR. LEMKOWITZ.
Radial Velocity of R Coronae	MR. FROST AND MR. HUBBLE.
Observations of Mira Ceti and R Leonis	MR. FROST AND MISS LOWATER.

Numerous other current reports may be expected, together with reviews of books.

At Yerkes Observatory January to June 1916.

HOURS OF OBSERVATION WITH 40-INCH TELESCOPE.

Month	1916	Mean for decade (1903-12)	Gain 1916
January	148	133	+15
February	141	125	+16
March	143.5	126.5	+17
April	134	120.5	+13.5
May	139	122	+17
June	123.5	133.5	−10
Total	829 hours	760.5 hours	68.5 hours

RAINFALL.

	Inches		Millimeters	
Month	1916	Decade	1916	Decade
January	4.05	1.52	103	38.6
February	.64	1.32	18	33.5
March	2.75	1.80	71	45.7
April	1.71	2.95	43	74.9
May	4.14	3.58	106	90.0
June	5.93	2.61	151	66.3
Total	19.22	13.78	492	350.0

Excess of Rainfall in 1916 = 5.44 inches or 142 millimetres.

A Faint Star with large Proper Motion.—Professor Edwin B. Frost, Director of the Yerkes Observatory, writes:—"From a comparison of his photographs taken with the 10-inch Bruce telescope, with the aid of the Zeiss blink-mikroskop, Professor Barnard has just discovered a star of the 11th magnitude having the remarkable annual proper motion of about 10″. The position of the star for 1916.0 is $17^h\ 53^m\ 44^s$, $+4°\ 27'.4$. This star follows B. D. $+4°3560$ by $9^s.5$ and is $0'.4$ north. The star is shown on several plates, one taken as far back as 1894 August 24, with the 6-inch Willard lens (at the Lick Observatory). The motion is almost directly north. The exact value of the motion will be published later."

The motion is confirmed by numerous Harvard photographs, the first of which were taken on May 22, 1888, and August 8, 1890.

The following position of Wolf's comet has been received here:—

G. M. T.	R. A.	Dec.	Observer	Place
	h m s	° ′ ″		
May 27.6893	12 29 48.60	+4 18 17.4	Barnard	Yerkes Observatory

EDWARD C. PICKERING.

Harvard College Observatory,
Bulletin 613. June 7, 1916.

NOTE:—An account of this star with photographs by Professor Barnard will be published in the next issue of POPULAR ASTRONOMY.

The Annual Conference of the Society for Practical Astronomy. The annual conference of the Society for Practical astronomy will be held in Rochester, New York, on August 24, 25 and 26 at the Bausch and Lomb Observatory. Rochester is a city of interest in optical matters and the meeting promises to be a success.

Latimer J. Wilson; president of the society, and director of the Planetary and Lunar Section is spending the summer at the observatory, where the eleven-inch refractor is being used for planetary and other observational work.

The Van Vleck Observatory of Wesleyan University at Middletown Conn., was dedicated on the afternoon of June 16, with the following order of exercises:

A WORD OF WELCOME

WILLIAM ARNOLD SHANKLIN

President of Wesleyan University

PRAYER

WILLIAM NORTH RICE, '65

Professor of Geology in Wesleyan University

THE FUNCTION OF THE VAN VLECK OBSERVATORY

FREDERICK SLOCUM

Director of the Van Vleck Observatory

ASTRONOMICAL RESEARCH AS NATIONAL SERVICE

GEORGE ELLERY HALE

Director of the Solar Observatory of the Carnegie Institution of Washington

ADDRESS

EDWARD BURR VAN VLECK, '84

Professor of Mathematics in the University of Wisconsin

UNVEILING OF TABLET

MASTER JOHN HASBROUCK VAN VLECK AND JOSEPH VAN VLECK, III.

THE DEDICATION

PRESIDENT WILLIAM ARNOLD SHANKLIN

The addresses were followed by a reception in the observatory library, and a general inspection of the building.

The observatory is the gift of the late Joseph Van Vleck, brother of the late Professor John Monroe Van Vleck, and is located on the top of a hill about three hundred yards due west of the Chapel. It is constructed of Portland brownstone.

The main part of the building is 40 by 80 feet, one story high, and contains a class-room, library, time-room, computing room, director's office, and an assistant's room. In a wing extending to the west is a transit room, containing two three-inch transits. At the end of a second wing, extending to the east, is the tower and dome for the chief instrument, a telescope of 18½ inches aperture, and 26 feet focal length. The completion of the lens for this instrument has been delayed by the war, and the 12-inch lens from the old observatory will be used temporarily in the new mounting.

For convenience in observing, the floor of the tower is an elevator, 33 feet in diameter, with a vertical range of 10 feet.

The basement contains two rooms for photographic work, a spectroscopic laboratory, and a workshop.

In addition to the telescope and two transits mentioned above, the observatory has a good equipment of apparatus for instruction and research. This includes three portable refractors, two spectroscopes, filar micrometer, photometer, altazimuth instrument, reflecting circle, two sextants, a 4-inch photographic doublet, two clocks, two chronometers, chronograph, comparator for photographic plates, and a computing machine.

The American Astronomical Society.—The nineteenth meeting of the American Astronomical Society will be held in the Sproul Observatory at Swarthmore, Pennsylvania, from Wednesday, August 30 to September 2, 1916. Not since the Washington meeting of December 1911 has there been a meeting east of the Alleghenies. Since then we have met in Pittsburgh just at the gateway to the early west, in Cleveland, in the south at Atlanta, in Evanston, and on the Pacific coast. The return to the East, the attractive programme, the opportunity to see two great, active observatories should bring out a record attendance. As Swarthmore affords inadequate hotel facilities at this season of the year arrangements have been made to accomodate the members in the college dormitories. In this way sleeping quarters, parlors, dining room, and the Observatory will be separated by not more than three minutes walk. The total cost for members coming for lunch on Wednesday and remaining until after lunch on Saturday, including all accomodations, will be $9.00. If on Friday we have luncheon at the Washington Inn at Valley Forge there will be be a charge of $1.00 the person. Professor Miller writes concerning recreation, that the tennis courts of the college will be accessible, that the swimming pool will be open, and that the Spring Haven Country Club, two miles away from the College, offers facilities for golf. Reservations for rooms should be made directly to Professor Miller. [From the Preliminary Announcement by Secretary Fox.

Falsifying the Time for the sake of Economy.—It has been called to our attention that a bill has been introduced in Congress, the purpose of which is to advance the hours of business by one hour during the summer time, not by changing the "legal" hours, but by the device of having all public clocks set ahead one hour.

This has been done in Germany, France and England, under the pressure of war expenses, on the theory that the reduction of the use of gas and electricity for one hour each night means in the aggregate an enormous saving. In the winter, late fall and early spring, the saving in the evening would be offset by the necessity of an extra hour of artificial illumination in the morning, so it is proposed to set the clocks back to correct time during that season.

We have nothing to say as to what action should be taken in other countries, but it seems to us that there is no need for this change in the United States, indeed that the change would be very objectionable.

Leaving out all astronomical considerations, where uniformity of time-reckoning is paramount, it would seem that in a country of such extent as the United States the annoyance resulting from the unavoidable confusion in both business and home life, attendant upon a sudden change of time twice a year, would more than balance the trifling saving to each person. In this country we have four divisions of Standard Time to which the people have become accustomed and which can cause little inconvenience if left undisturbed from year to year. To change all these twice a year could hardly fail to produce an immense amount of confusion.

The arrangement of the hours of Standard Time is an artificial one, it is true,

but it is a perfectly definite one and goes on from year to year just the same. The proposed arrangement is objectionable because of the inconstancy of the definition of the time under it and because of the change it demands arbitrarily in personal and business habits twice a year.

It has been argued in favor of the change that working people would have more hours of daylight for recreation in the evening. We fancy that most working people would prefer the extra hour of rest in the morning. In fact, our own experience with the hot spell through which we are just now passing, leads us to argue that it would be *criminally cruel* to force the poorer people, who must go to their work *by the clock* in the morning, to go to bed an hour earlier on the sweltering hot nights in July and August, in rooms that have little ventilation, and deprive them of an hour in the cool of the morning, the only time on many summer nights when restful sleep is possible.

Annals of the Dearborn Observatory.—Volume I of the Annals of the Dearborn Observatory of Northwestern University, Evanston, Illinois, has just come to hand. It is a quarto volume of 229 pages, giving a general account of the Dearborn Observatory, a study of the quality and the color curve of the 18½-inch objective of the telescope and a large number of measures of double stars by the director, Philip Fox. We congratulate Professor Fox on the publication of the first volume and hope it may be succeeded by many others in the years to come.

Observation of Sun Spots at Boston University.—Between September 23, 1915 and May 11, 1916, observations of sunspots were made at the Boston University Observatory on 53 dates. Spots were visible on all the days. The method of observation was the same as that described in POPULAR ASTRONOMY 229.

The weather conditions interfered with the work to a considerable extent. The resulting incompleteness of the record makes definite conclusions impossible. It may be of interest, however, to note certain results and make some comparisons with the observations of last year.

Sixty-six groups containing 361 spots were seen. The average number of groups for each observation increased from 0.67 last year to 1.24 this year, while the average number of spots increased from 3 to 6.8.

Between longitudes 140° and 210°, which includes the region where no spots were seen last year, 23 groups were seen, representing more than one third of all those observed. Between 0° and 90° there were 15 groups with 55 spots; from 90° to 180° 27 groups with 118 spots; from 180° to 270° 18 groups with 102 spots; and from 270° to 360° 9 groups with 86 spots.

Thirty-three groups with 203 spots were observed north of the equator; 33 groups with 158 spots, south. Four spots were seen within ten degrees of the equator; two north and two south. Between 10° and 20° north and south there were 22 and 19 groups respectively; between 20° and 30°, 6 north and 11 south. Three groups were seen having a latitude of more than 30° north.

Last year in the region from 120° to 210° no spots were seen in north latitude. and but one in south. This year that region contained an abundance of spots which were about equally distributed between north and south. The only sections this year without spots were in the north from 15° to 65° and from 218° to 260°. These same areas in the south, however, showed large groups.

The average latitude this year showed a drift since last year of about five degrees toward the equator, slightly more pronounced in north latitude. Four groups were seen within 10° of the equator, while none were seen in that region last year. There was a slight display of spots in latitudes higher than any observed last year.

In regard to the character of the groups, the most decided change was an increase in the number of groups containing a large number of nuclei.

PRISCILLA FAIRFIELD.